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THE

WORKS

OF

FRANCIS BACON,

BARON OF VERULAM, VISCOUNT ST. ALBANS, AND
LORD HIGH CHANCELLOR OF ENGLAND.

Collected and Edited

BY

JAMES SPEDDING, M. A.
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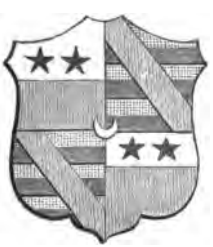
VOLUME VIII.



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PREFACE.*

WITH regard to the translations which occupy the first half of this volume (as far as p. 271.), I have nothing to add to what I have said (Vol. I. p. xiv.) in my general account of the edition.

With regard to the rest, I then intended merely to submit my suggestions to the translator, leaving it to him to make such alterations as he thought desirable; and about half of the fifth volume (which it was found convenient to print before the fourth) had been carried through on that plan, when an engagement on the Continent made it impossible for him to superintend the printing further: upon which he left his manuscript with me, to be dealt with as I thought fit. The consequence is that for the ultimate state of the whole of this volume,

* [The references in this preface apply to the English edition. To adapt them to this edition it will be necessary, for "the first half of this volume (as far as p. 271.)," to read this volume as far as p. 381, and, for "Vol. I. p. xiv.," to read Vol. I. p. xx. The words "about half of the fifth volume" describe all in this edition from p. 191 of volume nine through the translation of the *Historia Vitæ et Mortis* in volume ten; while the words "the whole of this volume, and the latter half of the next" apply to volume eight, volume nine through p. 190, and the remaining portion of volume ten.]

and the latter half of the next, I am myself responsible.

It may be well perhaps to add, that the translations are intended especially for the benefit of those who cannot read Latin. Those who can, will find the originals not only richer, stronger, and more impressive, but also (at least after a little practice) easier to follow and pleasanter to read. In Bacon's time Latin was still a living language among scholars. They used it not to show how well they could imitate the manner in which Cicero or Tacitus expressed his thoughts, but to express their own; and in Bacon's hands it became an organ of expression extremely powerful and sensitive, full of felicities and delicate effects, depending upon its own peculiar resources, and not transferable in the same form into a language of different structure. A literal translation in English might indeed *explain* them, and so help an imperfect scholar to understand the original if read along with it, but would not at all convey to an Englishman the effect of the original, if read by itself. The two languages differ so widely in their capacities and essential conditions, that the turn of expression which is neatest and clearest in the one is apt to be awkward and obscure in the other, and the translator must make his choice between a close version which shall not be readable, and a readable version which shall not be close. The translations

here given are meant to be read by themselves; and therefore, though I have taken pains to make them substantially accurate, and have never wittingly allowed a sentence to stand in which the meaning seemed to me to be misrepresented, I have not hesitated on the other hand to vary the form of expression whenever I have thought that the meaning could thereby be conveyed more clearly. In numberless cases indeed this has been done, I may say, on Bacon's own authority; a large part of the De Augmentis being in fact a translation from his own Advancement of Learning; although, owing to the additions, modifications, and corrections almost everywhere introduced, it has seldom been practicable to preserve the wording of the original English unaltered for many sentences together. Alterations for the purpose of improving the style and adapting it to modern fashion have not been attempted. All alterations of this kind which I have seen have been in my opinion for the worse; and no one who cares to read Bacon will find any difficulty in understanding his own English.

The selection of the works to be translated was made by Mr. Ellis, as including all that are necessary to give a complete view of Bacon's philosophical opinions.

J. S.

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TRANSLATIONS

OF

THE PHILOSOPHICAL WORKS.

PART I.

THE

GREAT INSTAURATION.

PROŒMIUM.

FRANCIS OF VERULAM

REASONED THUS WITH HIMSELF,

AND JUDGED IT TO BE FOR THE INTEREST OF THE PRESENT AND FUTURE GENERATIONS THAT THEY SHOULD BE MADE ACQUAINTED WITH HIS THOUGHTS.

BEING convinced that the human intellect makes its own difficulties, not using the true helps which are at man's disposal soberly and judiciously; whence follows manifold ignorance of things, and by reason of that ignorance mischiefs innumerable; he thought all trial should be made, whether that commerce between the mind of man and the nature of things, which is more precious than anything on earth, or at least than anything that is of the earth, might by any means be restored to its perfect and original condition, or if that may not be, yet reduced to a better condition than that in which it now is. Now that the errors which have hitherto prevailed, and which will prevail for ever, should (if the mind be left to go its own way), either by the natural force of the understanding or by help of the aids and instruments of Logic, one by one correct themselves, was a thing not to be hoped for: because the primary notions of things which the mind readily and passively imbibes, stores up, and accumulates (and it is from them that all the rest flow) are

false, confused, and overhastily abstracted from the facts; nor are the secondary and subsequent notions less arbitrary and inconstant; whence it follows that the entire fabric of human reason which we employ in the inquisition of nature, is badly put together and built up, and like some magnificent structure without any foundation. For while men are occupied in admiring and applauding the false powers of the mind, they pass by and throw away those true powers, which, if it be supplied with the proper aids and can itself be content to wait upon nature instead of vainly affecting to overrule her, are within its reach. There was but one course left, therefore, — to try the whole thing anew upon a better plan, and to commence a total reconstruction of sciences, arts, and all human knowledge, raised upon the proper foundations. And this, though in the project and undertaking it may seem a thing infinite and beyond the powers of man, yet when it comes to be dealt with it will be found sound and sober, more so than what has been done hitherto. For of this there is some issue; whereas in what is now done in the matter of science there is only a whirling round about, and perpetual agitation, ending where it began. And although he was well aware how solitary an enterprise it is, and how hard a thing to win faith and credit for, nevertheless he was resolved not to abandon either it or himself; nor to be deterred from trying and entering upon that one path which is alone open to the human mind. For better it is to make a beginning of that which may lead to something, than to engage in a perpetual struggle and pursuit in courses which have no exit. And certainly the two ways of contemplation are much

like those two ways of action, so much celebrated, in this — that the one, arduous and difficult in the beginning, leads out at last into the open country; while the other, seeming at first sight easy and free from obstruction, leads to pathless and precipitous places.

Moreover, because he knew not how long it might be before these things would occur to any one else, judging especially from this, that he has found no man hitherto who has applied his mind to the like, he resolved to publish at once so much as he has been able to complete. The cause of which haste was not ambition for himself, but solicitude for the work; that in case of his death there might remain some outline and project of that which he had conceived, and some evidence likewise of his honest mind and inclination towards the benefit of the human race. Certain it is that all other ambition whatsoever seemed poor in his eyes compared with the work which he had in hand; seeing that the matter at issue is either nothing, or a thing so great that it may well be content with its own merit, without seeking other recompence.

EPISTLE DEDICATORY.

TO OUR MOST GRACIOUS AND MIGHTY PRINCE AND LORD

JAMES,

BY THE GRACE OF GOD

OF GREAT BRITAIN, FRANCE, AND IRELAND KING,

DEFENDER OF THE FAITH, ETC.

Most Gracious and Mighty King,

YOUR Majesty may perhaps accuse me of larceny, having stolen from your affairs so much time as was required for this work. I know not what to say for myself. For of time there can be no restitution, unless it be that what has been abstracted from your business may perhaps go to the memory of your name and the honour of your age; if these things are indeed worth anything. Certainly they are quite new; totally new in their very kind: and yet they are copied from a very ancient model; even the world itself and the nature of things and of the mind. And to say truth, I am wont for my own part to regard this work as a child of time rather than of wit; the only wonder being that the first notion of the thing, and such great suspicions concerning matters long established, should have come into any man's mind. All the rest follows readily enough. And no doubt there is something of accident (as we call it) and luck as well in what men think as in what they do or say. But for this accident which I speak of, I wish that if there be any good in what I have to offer, it may be ascribed to the

infinite mercy and goodness of God, and to the felicity of your Majesty's times; to which as I have been an honest and affectionate servant in my life, so after my death I may yet perhaps, through the kindling of this new light in the darkness of philosophy, be the means of making this age famous to posterity; and surely to the times of the wisest and most learned of kings belongs of right the regeneration and restoration of the sciences. Lastly, I have a request to make — a request no way unworthy of your Majesty, and which especially concerns the work in hand; namely, that you who resemble Solomon in so many things — in the gravity of your judgments, in the peacefulness of your reign, in the largeness of your heart, in the noble variety of the books which you have composed — would further follow his example in taking order for the collecting and perfecting of a Natural and Experimental History, true and severe (unincumbered with literature and book-learning), such as philosophy may be built upon, — such, in fact, as I shall in its proper place describe: that so at length, after the lapse of so many ages, philosophy and the sciences may no longer float in air, but rest on the solid foundation of experience of every kind, and the same well examined and weighed. I have provided the machine, but the stuff must be gathered from the facts of nature. May God Almighty long preserve your Majesty!

Your Majesty's
Most bounden and devoted
Servant,

FRANCIS VERULAM,
CHANCELLOR.

THE GREAT INSTAURATION.

PREFACE.

That the state of knowledge is not prosperous nor greatly advancing; and that a way must be opened for the human understanding entirely different from any hitherto known, and other helps provided, in order that the mind may exercise over the nature of things the authority which properly belongs to it.

It seems to me that men do not rightly understand either their store or their strength, but overrate the one and underrate the other. Hence it follows, that either from an extravagant estimate of the value of the arts which they possess, they seek no further; or else from too mean an estimate of their own powers, they spend their strength in small matters and never put it fairly to the trial in those which go to the main. These are as the pillars of fate set in the path of knowledge; for men have neither desire nor hope to encourage them to penetrate further. And since opinion of store is one of the chief causes of want, and satisfaction with the present induces neglect of provision for the future, it becomes a thing not only useful, but absolutely necessary, that the excess of honour and admiration with which our existing stock of inventions is

regarded be in the very entrance and threshold of the work, and that frankly and without circumlocution, stripped off, and men be duly warned not to exaggerate or make too much of them. For let a man look carefully into all that variety of books with which the arts and sciences abound, he will find everywhere endless repetitions of the same thing, varying in the method of treatment, but not new in substance, insomuch that the whole stock, numerous as it appears at first view, proves on examination to be but scanty. And for its value and utility it must be plainly avowed that that wisdom which we have derived principally from the Greeks is but like the boyhood of knowledge, and has the characteristic property of boys: it can talk, but it cannot generate; for it is fruitful of controversies but barren of works. So that the state of learning as it now is appears to be represented to the life in the old fable of Scylla, who had the head and face of a virgin, but her womb was hung round with barking monsters, from which she could not be delivered. For in like manner the sciences to which we are accustomed have certain general positions which are specious and flattering; but as soon as they come to particulars, which are as the parts of generation, when they should produce fruit and works, then arise contentions and barking disputations, which are the end of the matter and all the issue they can yield. Observe also, that if sciences of this kind had any life in them, that could never have come to pass which has been the case now for many ages — that they stand almost at a stay, without receiving any augmentations worthy of the human race; insomuch that many times not only what was asserted once is asserted still, but what was a question once

is a question still, and instead of being resolved by discussion is only fixed and fed; and all the tradition and succession of schools is still a succession of masters and scholars, not of inventors and those who bring to further perfection the things invented. In the mechanical arts we do not find it so; they, on the contrary, as having in them some breath of life, are continually growing and becoming more perfect. As originally invented they are commonly rude, clumsy, and shapeless; afterwards they acquire new powers and more commodious arrangements and constructions; in so far that men shall sooner leave the study and pursuit of them and turn to something else, than they arrive at the ultimate perfection of which they are capable. Philosophy and the intellectual sciences, on the contrary, stand like statues, worshipped and celebrated, but not moved or advanced. Nay, they sometimes flourish most in the hands of the first author, and afterwards degenerate. For when men have once made over their judgments to others' keeping, and (like those senators whom they called *Pedarii*) have agreed to support some one person's opinion, from that time they make no enlargement of the sciences themselves, but fall to the servile office of embellishing certain individual authors and increasing their retinue. And let it not be said that the sciences have been growing gradually till they have at last reached their full stature, and so (their course being completed) have settled in the works of a few writers; and that there being now no room for the invention of better, all that remains is to embellish and cultivate those things which have been invented already. Would it were so! But the truth is that

this appropriating of the sciences has its origin in nothing better than the confidence of a few persons and the sloth and indolence of the rest. For after the sciences had been in several parts perhaps cultivated and handled diligently, there has risen up some man of bold disposition, and famous for methods and short ways which people like, who has in appearance reduced them to an art, while he has in fact only spoiled all that the others had done. And yet this is what posterity like, because it makes the work short and easy, and saves further inquiry, of which they are weary and impatient. And if any one take this general acquiescence and consent for an argument of weight, as being the judgment of Time, let me tell him that the reasoning on which he relies is most fallacious and weak. For, first, we are far from knowing all that in the matter of sciences and arts has in various ages and places been brought to light and published; much less, all that has been by private persons secretly attempted and stirred; so neither the births nor the miscarriages of Time are entered in our records. Nor, secondly, is the consent itself and the time it has continued a consideration of much worth. For however various are the forms of civil polities, there is but one form of polity in the sciences; and that always has been and always will be popular. Now the doctrines which find most favour with the populace are those which are either contentious and pugnacious, or specious and empty; such, I say, as either entangle assent or tickle it. And therefore no doubt the greatest wits in each successive age have been forced out of their own course; men of capacity and intellect above the vulgar having been fain, for

reputation's sake, to bow to the judgment of the time and the multitude; and thus if any contemplations of a higher order took light anywhere, they were presently blown out by the winds of vulgar opinions. So that Time is like a river, which has brought down to us things light and puffed up, while those which are weighty and solid have sunk. Nay, those very authors who have usurped a kind of dictatorship in the sciences and taken upon them to lay down the law with such confidence, yet when from time to time they come to themselves again, they fall to complaints of the subtlety of nature, the hiding-places of truth, the obscurity of things, the entanglement of causes, the weakness of the human mind; wherein nevertheless they show themselves never the more modest, seeing that they will rather lay the blame upon the common condition of men and nature than upon themselves. And then whatever any art fails to attain, they ever set it down upon the authority of that art itself as impossible of attainment; and how can art be found guilty when it is judge in its own cause? So it is but a device for exempting ignorance from ignominy. Now for those things which are delivered and received, this is their condition: barren of works, full of questions; in point of enlargement slow and languid; carrying a show of perfection in the whole, but in the parts ill filled up; in selection popular, and unsatisfactory even to those who propound them; and therefore fenced round and set forth with sundry artifices. And if there be any who have determined to make trial for themselves, and put their own strength to the work of advancing the boundaries of the sciences, yet have they not ventured to cast themselves completely loose from received opin-

ions or to seek their knowledge at the fountain; but they think they have done some great thing if they do but add and introduce into the existing sum of science something of their own; prudently considering with themselves that by making the addition they can assert their liberty, while they retain the credit of modesty by assenting to the rest. But these mediocrities and middle ways so much praised, in deferring to opinions and customs, turn to the great detriment of the sciences. For it is hardly possible at once to admire an author and to go beyond him; knowledge being as water, which will not rise above the level from which it fell. Men of this kind, therefore, amend some things, but advance little; and improve the condition of knowledge, but do not extend its range. Some, indeed, there have been who have gone more boldly to work, and taking it all for an open matter and giving their genius full play, have made a passage for themselves and their own opinions by pulling down and demolishing former ones; and yet all their stir has but little advanced the matter; since their aim has been not to extend philosophy and the arts in substance and value, but only to change doctrines and transfer the kingdom of opinions to themselves; whereby little has indeed been gained, for though the error be the opposite of the other, the causes of erring are the same in both. And if there have been any who, not binding themselves either to other men's opinions or to their own, but loving liberty, have desired to engage others along with themselves in search, these, though honest in intention, have been weak in endeavour. For they have been content to follow probable reasons, and are carried round in a whirl of argu-

ments, and in the promiscuous liberty of search have relaxed the severity of inquiry. There is none who has dwelt upon experience and the facts of nature as long as is necessary. Some there are indeed who have committed themselves to the waves of experience, and almost turned mechanics; yet these again have in their very experiments pursued a kind of wandering inquiry, without any regular system of operations. And besides they have mostly proposed to themselves certain petty tasks, taking it for a great matter to work out some single discovery; — a course of proceeding at once poor in aim and unskilful in design. For no man can rightly and successfully investigate the nature of anything in the thing itself; let him vary his experiments as laboriously as he will, he never comes to a resting-place, but still finds something to seek beyond. And there is another thing to be remembered; namely, that all industry in experimenting has begun with proposing to itself certain definite works to be accomplished, and has pursued them with premature and unseasonable eagerness; it has sought, I say, experiments of Fruit, not experiments of Light; not imitating the divine procedure, which in its first day's work created light only and assigned to it one entire day; on which day it produced no material work, but proceeded to that on the days following. As for those who have given the first place to Logic, supposing that the surest helps to the sciences were to be found in that, they have indeed most truly and excellently perceived that the human intellect left to its own course is not to be trusted; but then the remedy is altogether too weak for the disease; nor is it without evil in itself. For the Logic which is received, though it be very

properly applied to civil business and to those arts which rest in discourse and opinion, is not nearly subtle enough to deal with nature; and in offering at what it cannot master, has done more to establish and perpetuate error than to open the way to truth.

Upon the whole therefore, it seems that men have not been happy hitherto either in the trust which they have placed in others or in their own industry with regard to the sciences; especially as neither the demonstrations nor the experiments as yet known are much to be relied upon. But the universe to the eye of the human understanding is framed like a labyrinth; presenting as it does on every side so many ambiguities of way, such deceitful resemblances of objects and signs, natures so irregular in their lines, and so knotted and entangled. And then the way is still to be made by the uncertain light of the sense, sometimes shining out, sometimes clouded over, through the woods of experience and particulars; while those who offer themselves for guides are (as was said) themselves also puzzled, and increase the number of errors and wanderers. In circumstances so difficult neither the natural force of man's judgment nor even any accidental felicity offers any chance of success. No excellence of wit, no repetition of chance experiments, can overcome such difficulties as these. Our steps must be guided by a clue, and the whole way from the very first perception of the senses must be laid out upon a sure plan. Not that I would be understood to mean that nothing whatever has been done in so many ages by so great labours. We have no reason to be ashamed of the discoveries which have been made, and no doubt the ancients proved themselves in everything that turns on wit and

abstract meditation, wonderful men. But as in former ages when men sailed only by observation of the stars, they could indeed coast along the shores of the old continent or cross a few small and mediterranean seas; but before the ocean could be traversed and the new world discovered, the use of the mariner's needle, as a more faithful and certain guide, had to be found out; in like manner the discoveries which have been hitherto made in the arts and sciences are such as might be made by practice, meditation, observation, argumentation, — for they lay near to the senses, and immediately beneath common notions; but before we can reach the remoter and more hidden parts of nature, it is necessary that a more perfect use and application of the human mind and intellect be introduced.

For my own part at least, in obedience to the everlasting love of truth, I have committed myself to the uncertainties and difficulties and solitudes of the ways, and relying on the divine assistance have upheld my mind both against the shocks and embattled ranks of opinion, and against my own private and inward hesitations and scruples, and against the fogs and clouds of nature, and the phantoms flitting about on every side; in the hope of providing at last for the present and future generations guidance more faithful and secure. Wherein if I have made any progress, the way has been opened to me by no other means than the true and legitimate humiliation of the human spirit. For all those who before me have applied themselves to the invention of arts have but cast a glance or two upon facts and examples and experience, and straightway proceeded, as if invention were nothing more than an exercise of thought, to invoke their own spirits to give

them oracles. I, on the contrary, dwelling purely and constantly among the facts of nature, withdraw my intellect from them no further than may suffice to let the images and rays of natural objects meet in a point, as they do in the sense of vision; whence it follows that the strength and excellency of the wit has but little to do in the matter. And the same humility which I use in inventing I employ likewise in teaching. For I do not endeavour either by triumphs of confutation, or pleadings of antiquity, or assumption of authority, or even by the veil of obscurity, to invest these inventions of mine with any majesty; which might easily be done by one who sought to give lustre to his own name rather than light to other men's minds. I have not sought (I say) nor do I seek either to force or ensnare men's judgments, but I lead them to things themselves and the concordances of things, that they may see for themselves what they have, what they can dispute, what they can add and contribute to the common stock. And for myself, if in anything I have been either too credulous or too little awake and attentive, or if I have fallen off by the way and left the inquiry incomplete, nevertheless I so present these things naked and open, that my errors can be marked and set aside before the mass of knowledge be further infected by them; and it will be easy also for others to continue and carry on my labours. And by these means I suppose that I have established for ever a true and lawful marriage between the empirical and the rational faculty, the unkind and ill-starred divorce and separation of which has thrown into confusion all the affairs of the human family.

Wherefore, seeing that these things do not depend upon myself, at the outset of the work I most humbly

and fervently pray to God the Father, God the Son, and God the Holy Ghost, that remembering the sorrows of mankind and the pilgrimage of this our life wherein we wear out days few and evil, they will vouchsafe through my hands to endow the human family with new mercies. This likewise I humbly pray, that things human may not interfere with things divine, and that from the opening of the ways of sense and the increase of natural light there may arise in our minds no incredulity or darkness with regard to the divine mysteries; but rather that the understanding being thereby purified and purged of fancies and vanity, and yet not the less subject and entirely submissive to the divine oracles, may give to faith that which is faith's. Lastly, that knowledge being now discharged of that venom which the serpent infused into it, and which makes the mind of man to swell, we may not be wise above measure and sobriety, but cultivate truth in charity.

And now having said my prayers I turn to men; to whom I have certain salutary admonitions to offer and certain fair requests to make. My first admonition (which was also my prayer) is that men confine the sense within the limits of duty in respect of things divine: for the sense is like the sun, which reveals the face of earth, but seals and shuts up the face of heaven. My next, that in flying from this evil they fall not into the opposite error, which they will surely do if they think that the inquisition of nature is in any part interdicted or forbidden. For it was not that pure and uncorrupted natural knowledge whereby Adam gave names to the creatures according to their propriety, which gave occasion to the fall. It was the ambitious and proud desire of moral knowledge to judge of good

and evil, to the end that man may revolt from God and give laws to himself, which was the form and manner of the temptation. Whereas of the sciences which regard nature, the divine philosopher declares that "it is the glory of God to conceal a thing, but it is the glory of the King to find a thing out." Even as though the divine nature took pleasure in the innocent and kindly sport of children playing at hide and seek, and vouchsafed of his kindness and goodness to admit the human spirit for his playfellow at that game. Lastly, I would address one general admonition to all; that they consider what are the true ends of knowledge, and that they seek it not either for pleasure of the mind, or for contention, or for superiority to others, or for profit, or fame, or power, or any of these inferior things; but for the benefit and use of life; and that they perfect and govern it in charity. For it was from lust of power that the angels fell, from lust of knowledge that man fell; but of charity there can be no excess, neither did angel or man ever come in danger by it.

The requests I have to make are these. Of myself I say nothing; but in behalf of the business which is in hand I entreat men to believe that it is not an opinion to be held, but a work to be done; and to be well assured that I am labouring to lay the foundation, not of any sect or doctrine, but of human utility and power. Next, I ask them to deal fairly by their own interests, and laying aside all emulations and prejudices in favour of this or that opinion, to join in consultation for the common good; and being now freed and guarded by the securities and helps which I offer from the errors and impediments of the way, to come forward themselves and take part in that which remains to be

done. Moreover, to be of good hope, nor to imagine that this Instauration of mine is a thing infinite and beyond the power of man, when it is in fact the true end and termination of infinite error; and seeing also that it is by no means forgetful of the conditions of mortality and humanity, (for it does not suppose that the work can be altogether completed within one generation, but provides for its being taken up by another); and finally that it seeks for the sciences not arrogantly in the little cells of human wit, but with reverence in the greater world. But it is the empty things that are vast: things solid are most contracted and lie in little room. And now I have only one favour more to ask (else injustice to me may perhaps imperil the business itself)—that men will consider well how far, upon that which I must needs assert (if I am to be consistent with myself), they are entitled to judge and decide upon these doctrines of mine; inasmuch as all that premature human reasoning which anticipates inquiry, and is abstracted from the facts rashly and sooner than is fit, is by me rejected (so far as the inquisition of nature is concerned), as a thing uncertain, confused, and ill built up; and I cannot be fairly asked to abide by the decision of a tribunal which is itself on its trial.

THE PLAN OF THE WORK.

The work is in six Parts:—

1. *The Divisions of the Sciences.*
2. *The New Organon; or Directions concerning the Interpretation of Nature.*
3. *The Phenomena of the Universe; or a Natural and Experimental History for the foundation of Philosophy.*
4. *The Ladder of the Intellect.*
5. *The Forerunners; or Anticipations of the New Philosophy.*
6. *The New Philosophy; or Active Science.*

The Arguments of the several Parts.

It being part of my design to set everything forth, as far as may be, plainly and perspicuously (for nakedness of the mind is still, as nakedness of the body once was, the companion of innocence and simplicity), let me first explain the order and plan of the work. I distribute it into six parts.

The first part exhibits a summary or general description of the knowledge which the human race at present possesses. For I thought it good to make some pause upon that which is received; that thereby the old may be more easily made perfect and the new more

easily approached. And I hold the improvement of that which we have to be as much an object as the acquisition of more. Besides which it will make me the better listened to; for "He that is ignorant (says the proverb) receives not the words of knowledge, unless thou first tell him that which is in his own heart." We will therefore make a coasting voyage along the shores of the arts and sciences received; not without importing into them some useful things by the way.

In laying out the divisions of the sciences however, I take into account not only things already invented and known, but likewise things omitted which ought to be there. For there are found in the intellectual as in the terrestrial globe waste regions as well as cultivated ones. It is no wonder therefore if I am sometimes obliged to depart from the ordinary divisions. For in adding to the total you necessarily alter the parts and sections; and the received divisions of the sciences are fitted only to the received sum of them as it stands now.

With regard to those things which I shall mark as omitted, I intend not merely to set down a simple title or a concise argument of that which is wanted. For as often as I have occasion to report anything as deficient, the nature of which is at all obscure, so that men may not perhaps easily understand what I mean or what the work is which I have in my head, I shall always (provided it be a matter of any worth) take care to subjoin either directions for the execution of such work, or else a portion of the work itself executed by myself as a sample of the whole: thus giving assistance in every case either by work or by counsel. For if it were for the sake of my own reputation only and

other men's interests were not concerned in it, I would not have any man think that in such cases merely some light and vague notion has crossed my mind, and that the things which I desire and offer at are no better than wishes; when they are in fact things which men may certainly command if they will, and of which I have formed in my own mind a clear and detailed conception. For I do not propose merely to survey these regions in my mind, like an augur taking auspices, but to enter them like a general who means to take possession. — So much for the first part of the work.

Having thus coasted past the ancient arts, the next point is to equip the intellect for passing beyond. To the second part therefore belongs the doctrine concerning the better and more perfect use of human reason in the inquisition of things, and the true helps of the understanding: that thereby (as far as the condition of mortality and humanity allows) the intellect may be raised and exalted, and made capable of overcoming the difficulties and obscurities of nature. The art which I introduce with this view (which I call *Interpretation of Nature*) is a kind of logic; though the difference between it and the ordinary logic is great; indeed immense. For the ordinary logic professes to contrive and prepare helps and guards for the understanding, as mine does; and in this one point they agree. But mine differs from it in three points especially; viz. in the end aimed at; in the order of demonstration; and in the starting point of the inquiry.

For the end which this science of mine proposes is the invention not of arguments but of arts; not of things in accordance with principles, but of principles

themselves; not of probable reasons, but of designations and directions for works. And as the intention is different, so accordingly is the effect; the effect of the one being to overcome an opponent in argument, of the other to command nature in action.

In accordance with this end is also the nature and order of the demonstrations. For in the ordinary logic almost all the work is spent about the syllogism. Of induction the logicians seem hardly to have taken any serious thought, but they pass it by with a slight notice, and hasten on to the formulæ of disputation. I on the contrary reject demonstration by syllogism, as acting too confusedly, and letting nature slip out of its hands. For although no one can doubt that things which agree in a middle term agree with one another (which is a proposition of mathematical certainty), yet it leaves an opening for deception; which is this. The syllogism consists of propositions; propositions of words; and words are the tokens and signs of notions. Now if the very notions of the mind (which are as the soul of words and the basis of the whole structure) be improperly and over-hastily abstracted from facts, vague, not sufficiently definite, faulty in short in many ways, the whole edifice tumbles. I therefore reject the syllogism; and that not only as regards principles (for to principles the logicians themselves do not apply it) but also as regards middle propositions; which, though obtainable no doubt by the syllogism, are, when so obtained, barren of works, remote from practice, and altogether unavailable for the active department of the sciences. Although therefore I leave to the syllogism and these famous and boasted modes of demonstration their jurisdiction over popular arts and such as are matter of

opinion (in which department I leave all as it is), yet in dealing with the nature of things I use induction throughout, and that in the minor propositions as well as the major. For I consider induction to be that form of demonstration which upholds the sense, and closes with nature, and comes to the very brink of operation, if it does not actually deal with it.

Hence it follows that the order of demonstration is likewise inverted. For hitherto the proceeding has been to fly at once from the sense and particulars up to the most general propositions, as certain fixed poles for the argument to turn upon, and from these to derive the rest by middle terms: a short way, no doubt, but precipitate; and one which will never lead to nature, though it offers an easy and ready way to disputation. Now my plan is to proceed regularly and gradually from one axiom to another, so that the most general are not reached till the last: but then when you do come to them you find them to be not empty notions, but well defined, and such as nature would really recognise as her first principles, and such as lie at the heart and marrow of things.

But the greatest change I introduce is in the form itself of induction and the judgment made thereby. For the induction of which the logicians speak, which proceeds by simple enumeration, is a puerile thing; concludes at hazard; is always liable to be upset by a contradictory instance; takes into account only what is known and ordinary; and leads to no result.

Now what the sciences stand in need of is a form of induction which shall analyse experience and take it to pieces, and by a due process of exclusion and rejection lead to an inevitable conclusion. And if that

ordinary mode of judgment practised by the logicians was so laborious, and found exercise for such great wits, how much more labour must we be prepared to bestow upon this other, which is extracted not merely out of the depths of the mind, but out of the very bowels of nature.

Nor is this all. For I also sink the foundations of the sciences deeper and firmer; and I begin the inquiry nearer the source than men have done heretofore; submitting to examination those things which the common logic takes on trust. For first, the logicians borrow the principles of each science from the science itself; secondly, they hold in reverence the first notions of the mind; and lastly, they receive as conclusive the immediate informations of the sense, when well disposed. Now upon the first point, I hold that true logic ought to enter the several provinces of science armed with a higher authority than belongs to the principles of those sciences themselves, and ought to call those putative principles to account until they are fully established. Then with regard to the first notions of the intellect; there is not one of the impressions taken by the intellect when left to go its own way, but I hold it for suspected, and no way established, until it has submitted to a new trial and a fresh judgment has been thereupon pronounced. And lastly, the information of the sense itself I sift and examine in many ways. For certain it is that the senses deceive; but then at the same time they supply the means of discovering their own errors; only the errors are here, the means of discovery are to seek.

The sense fails in two ways. Sometimes it gives no information, sometimes it gives false information. For

first, there are very many things which escape the sense, even when best disposed and no way obstructed; by reason either of the subtlety of the whole body, or the minuteness of the parts, or distance of place, or slowness or else swiftness of motion, or familiarity of the object, or other causes. And again when the sense does apprehend a thing its apprehension is not much to be relied upon. For the testimony and information of the sense has reference always to man, not to the universe; and it is a great error to assert that the sense is the measure of things.

To meet these difficulties, I have sought on all sides diligently and faithfully to provide helps for the sense —substitutes to supply its failures, rectifications to correct its errors; and this I endeavour to accomplish not so much by instruments as by experiments. For the subtlety of experiments is far greater than that of the sense itself, even when assisted by exquisite instruments; such experiments, I mean, as are skilfully and artificially devised for the express purpose of determining the point in question. To the immediate and proper perception of the sense therefore I do not give much weight; but I contrive that the office of the sense shall be only to judge of the experiment, and that the experiment itself shall judge of the thing. And thus I conceive that I perform the office of a true priest of the sense (from which all knowledge in nature must be sought, unless men mean to go mad) and a not unskilful interpreter of its oracles; and that while others only profess to uphold and cultivate the sense, I do so in fact. Such then are the provisions I make for finding the genuine light of nature and kindling and bringing it to bear. And they would

be sufficient of themselves, if the human intellect were even, and like a fair sheet of paper with no writing on it. But since the minds of men are strangely possessed and beset, so that there is no true and even surface left to reflect the genuine rays of things, it is necessary to seek a remedy for this also.

Now the idols, or phantoms, by which the mind is occupied are either adventitious or innate. The adventitious come into the mind from without; namely, either from the doctrines and sects of philosophers, or from perverse rules of demonstration. But the innate are inherent in the very nature of the intellect, which is far more prone to error than the sense is. For let men please themselves as they will in admiring and almost adoring the human mind, this is certain: that as an uneven mirror distorts the rays of objects according to its own figure and section, so the mind, when it receives impressions of objects through the sense, cannot be trusted to report them truly, but in forming its notions mixes up its own nature with the nature of things.

And as the first two kinds of idols are hard to eradicate, so idols of this last kind cannot be eradicated at all. All that can be done is to point them out, so that this insidious action of the mind may be marked and reproved (else as fast as old errors are destroyed new ones will spring up out of the ill complexion of the mind itself, and so we shall have but a change of errors, and not a clearance); and to lay it down once for all as a fixed and established maxim, that the intellect is not qualified to judge except by means of induction, and induction in its legitimate form. This doctrine then of the expurgation of the intellect to qualify it

for dealing with truth, is comprised in three refutations: the refutation of the Philosophies; the refutation of the Demonstrations; and the refutation of the Natural Human Reason. The explanation of which things, and of the true relation between the nature of things and the nature of the mind, is as the strewing and decoration of the bridal chamber of the Mind and the Universe, the Divine Goodness assisting; out of which marriage let us hope (and be this the prayer of the bridal song) there may spring helps to man, and a line and race of inventions that may in some degree subdue and overcome the necessities and miseries of humanity. This is the second part of the work.

But I design not only to indicate and mark out the ways, but also to enter them. And therefore the third part of the work embraces the Phenomena of the Universe; that is to say, experience of every kind, and such a natural history as may serve for a foundation to build philosophy upon. For a good method of demonstration or form of interpreting nature may keep the mind from going astray or stumbling, but it is not any excellence of method that can supply it with the material of knowledge. Those however who aspire not to guess and divine, but to discover and know; who propose not to devise mimic and fabulous worlds of their own, but to examine and dissect the nature of this very world itself; must go to facts themselves for everything. Nor can the place of this labour and search and worldwide perambulation be supplied by any genius or meditation or argumentation; no, not if all men's wits could meet in one. This therefore we must have, or the business must be for ever abandoned.

But up to this day such has been the condition of men in this matter, that it is no wonder if nature will not give herself into their hands.

For first, the information of the sense itself, sometimes failing, sometimes false; observation, careless, irregular, and led by chance; tradition, vain and fed on rumour; practice, slavishly bent upon its work; experiment, blind, stupid, vague, and prematurely broken off; lastly, natural history trivial and poor; — all these have contributed to supply the understanding with very bad materials for philosophy and the sciences.

Then an attempt is made to mend the matter by a preposterous subtlety and winnowing of argument. But this comes too late, the case being already past remedy; and is far from setting the business right or sifting away the errors. The only hope therefore of any greater increase or progress lies in a reconstruction of the sciences.

Of this reconstruction the foundation must be laid in natural history, and that of a new kind and gathered on a new principle. For it is in vain that you polish the mirror if there are no images to be reflected; and it is as necessary that the intellect should be supplied with fit matter to work upon, as with safeguards to guide its working. But my history differs from that in use (as my logic does) in many things, — in end and office, in mass and composition, in subtlety, in selection also and setting forth, with a view to the operations which are to follow.

For first, the object of the natural history which I propose is not so much to delight with variety of matter or to help with present use of experiments, as to

give light to the discovery of causes and supply a suckling philosophy with its first food. For though it be true that I am principally in pursuit of works and the active department of the sciences, yet I wait for harvest-time, and do not attempt to mow the moss or to reap the green corn. For I well know that axioms once rightly discovered will carry whole troops of works along with them, and produce them, not here and there one; but in clusters. And that unseasonable and puerile hurry to snatch by way of earnest at the first works which come within reach, I utterly condemn and reject, as an Atalanta's apple that hinders the race. Such then is the office of this natural history of mine.

Next, with regard to the mass and composition of it: I mean it to be a history not only of nature free and at large (when she is left to her own course and does her work her own way), — such as that of the heavenly bodies, meteors, earth and sea, minerals, plants, animals, — but much more of nature under constraint and vexed; that is to say, when by art and the hand of man she is forced out of her natural state, and squeezed and moulded. Therefore I set down at length all experiments of the mechanical arts, of the operative part of the liberal arts, of the many crafts which have not yet grown into arts properly so called, so far as I have been able to examine them and as they conduce to the end in view. Nay (to say the plain truth) I do in fact (low and vulgar as men may think it) count more upon this part both for helps and safeguards than upon the other; seeing that the nature of things betrays itself more readily under the vexations of art than in its natural freedom.

Nor do I confine the history to Bodies; but I have

thought it my duty besides to make a separate history of such Virtues as may be considered cardinal in nature. I mean those original passions or desires of matter which constitute the primary elements of nature; such as Dense and Rare, Hot and Cold, Solid and Fluid, Heavy and Light, and several others.

Then again, to speak of subtlety: I seek out and get together a kind of experiments much subtler and simpler than those which occur accidentally. For I drag into light many things which no one who was not proceeding by a regular and certain way to the discovery of causes would have thought of inquiring after; being indeed in themselves of no great use; which shows that they were not sought for on their own account; but having just the same relation to things and works which the letters of the alphabet have to speech and words — which, though in themselves useless, are the elements of which all discourse is made up.

Further, in the selection of the relation and experiments I conceive I have been a more cautious purveyor than those who have hitherto dealt with natural history. For I admit nothing but on the faith of eyes, or at least of careful and severe examination; so that nothing is exaggerated for wonder's sake, but what I state is sound and without mixture of fables or vanity. All received or current falsehoods also (which by strange negligence have been allowed for many ages to prevail and become established) I proscribe and brand by name; that the sciences may be no more troubled with them. For it has been well observed that the fables and superstitions and follies which nurses instil into children do serious injury to their minds; and the same consideration makes me anxious, having the

management of the childhood as it were of philosophy in its course of natural history, not to let it accustom itself in the beginning to any vanity. Moreover, whenever I come to a new experiment of any subtlety (though it be in my own opinion certain and approved), I nevertheless subjoin a clear account of the manner in which I made it; that men knowing exactly how each point was made out, may see whether there be any error connected with it, and may arouse themselves to devise proofs more trustworthy and exquisite, if such can be found; and finally, I interpose everywhere admonitions and scruples and cautions, with a religious care to eject, repress, and as it were exorcise every kind of phantasm.

Lastly, knowing how much the sight of man's mind is distracted by experience and history, and how hard it is at the first (especially for minds either tender or preoccupied) to become familiar with nature, I not unfrequently subjoin observations of my own, being as the first offers, inclinations, and as it were glances of history towards philosophy; both by way of an assurance to men that they will not be kept for ever tossing on the waves of experience, and also that when the time comes for the intellect to begin its work, it may find everything the more ready. By such a natural history then as I have described, I conceive that a safe and convenient approach may be made to nature, and matter supplied of good quality and well prepared for the understanding to work upon.

And now that we have surrounded the intellect with faithful helps and guards, and got together with most careful selection a regular army of divine works, it may

seem that we have no more to do but to proceed to philosophy itself. And yet in a matter so difficult and doubtful there are still some things which it seems necessary to premise, partly for convenience of explanation, partly for present use.

Of these the first is to set forth examples of inquiry and invention according to my method, exhibited by anticipation in some particular subjects; choosing such subjects as are at once the most noble in themselves among those under inquiry, and most different one from another; that there may be an example in every kind. I do not speak of those examples which are joined to the several precepts and rules by way of illustration (for of these I have given plenty in the second part of the work); but I mean actual types and models, by which the entire process of the mind and the whole fabric and order of invention from the beginning to the end, in certain subjects, and those various and remarkable, should be set as it were before the eyes. For I remember that in the mathematics it is easy to follow the demonstration when you have a machine beside you; whereas without that help all appears involved and more subtle than it really is. To examples of this kind, — being in fact nothing more than an application of the second part in detail and at large, — the fourth part of the work is devoted.

The fifth part is for temporary use only, pending the completion of the rest; like interest payable from time to time until the principal be forthcoming. For I do not make so blindly for the end of my journey, as to neglect anything useful that may turn up by the way. And therefore I include in this fifth part such things

as I nave myself discovered, proved, or added, — not however according to the true rules and methods of interpretation, but by the ordinary use of the understanding in inquiring and discovering. For besides that I hope my speculations may in virtue of my continual conversancy with nature have a value beyond the pretensions of my wit, they will serve in the meantime for wayside inns, in which the mind may rest and refresh itself on its journey to more certain conclusions. Nevertheless I wish it to be understood in the meantime that they are conclusions by which (as not being discovered and proved by the true form of interpretation) I do not at all mean to bind myself. Nor need any one be alarmed at such suspension of judgment, in one who maintains not simply that nothing can be known, but only that nothing can be known except in a certain course and way; and yet establishes provisionally certain degrees of assurance, for use and relief until the mind shall arrive at a knowledge of causes in which it can rest. For even those schools of philosophy which held the absolute impossibility of knowing anything were not inferior to those which took upon them to pronounce. But then they did not provide helps for the sense and understanding, as I have done, but simply took away all their authority: which is quite a different thing — almost the reverse.

The sixth part of my work (to which the rest is subservient and ministrant) discloses and sets forth that philosophy which by the legitimate, chaste, and severe course of inquiry which I have explained and provided is at length developed and established. The completion however of this last part is a thing both above my

strength and beyond my hopes. I have made a beginning of the work — a beginning, as I hope, not unimportant: — the fortune of the human race will give the issue; — such an issue, it may be, as in the present condition of things and men's minds cannot easily be conceived or imagined. For the matter in hand is no mere felicity of speculation, but the real business and fortunes of the human race, and all power of operation. For man is but the servant and interpreter of nature: what he does and what he knows is only what he has observed of nature's order in fact or in thought; beyond this he knows nothing and can do nothing. For the chain of causes cannot by any force be loosed or broken, nor can nature be commanded except by being obeyed. And so those twin objects, human Knowledge and human Power, do really meet in one; and it is from ignorance of causes that operation fails.

And all depends on keeping the eye steadily fixed upon the facts of nature and so receiving their images simply as they are. For God forbid that we should give out a dream of our own imagination for a pattern of the world; rather may he graciously grant to us to write an apocalypse or true vision of the footsteps of the Creator imprinted on his creatures.

Therefore do thou, O Father, who gavest the visible light as the first fruits of creation, and didst breathe into the face of man the intellectual light as the crown and consummation thereof, guard and protect this work, which coming from thy goodness returneth to thy glory. Thou when thou turnedst to look upon the works which thy hands had made, sawest that all was very good, and didst rest from thy labours. But man, when he turned to look upon the work which his hands had

made, saw that all was vanity and vexation of spirit, and could find no rest therein. Wherefore if we labour in thy works with the sweat of our brows thou wilt make us partakers of thy vision and thy sabbath. Humbly we pray that this mind may be steadfast in us, and that through these our hands, and the hands of others to whom thou shalt give the same spirit, thou wilt vouchsafe to endow the human family with new mercies.

THE

FIRST PART OF THE INSTAURATION,

WHICH COMPRISES THE

DIVISIONS OF THE SCIENCES,

IS WANTING.

But some account of them will be found in the Second Book of the "Proficience and Advancement of Learning, Divine and Human."

Next comes

THE

SECOND PART OF THE INSTAURATION,

WHICH EXHIBITS

THE ART ITSELF OF INTERPRETING NATURE,

AND OF THE TRUER EXERCISE OF THE INTELLECT;

Not however in the form of a regular Treatise, but only a Summary digested into Aphorisms.

THE

SECOND PART OF THE WORK,

WHICH IS CALLED

THE NEW ORGANON;

OR,

TRUE DIRECTIONS

CONCERNING

THE INTERPRETATION OF NATURE.

PREFACE.

THOSE who have taken upon them to lay down the law of nature as a thing already searched out and understood, whether they have spoken in simple assurance or professional affectation, have therein done philosophy and the sciences great injury. For as they have been successful in inducing belief, so they have been effective in quenching and stopping inquiry; and have done more harm by spoiling and putting an end to other men's efforts than good by their own. Those on the other hand who have taken a contrary course, and asserted that absolutely nothing can be known, — whether it were from hatred of the ancient sophists, or from uncertainty and fluctuation of mind, or even from a kind of fulness of learning, that they fell upon this opinion, — have certainly advanced reasons for it that are not to be despised; but yet they have neither started from true principles nor rested in the just conclusion, zeal and affectation having carried them much too far. The more ancient of the Greeks (whose writings are lost) took up with better judgment a position between these two extremes, — between the presumption of pronouncing on everything, and the despair of comprehending anything; and though frequently and bitterly complaining of the difficulty of inquiry and the

obscurity of things, and like impatient horses champing the bit, they did not the less follow up their object and engage with Nature; thinking (it seems) that this very question, — viz. whether or no anything can be known, — was to be settled not by arguing, but by trying. And yet they too, trusting entirely to the force of their understanding, applied no rule, but made everything turn upon hard thinking and perpetual working and exercise of the mind.

Now my method, though hard to practise, is easy to explain; and it is this. I propose to establish progressive stages of certainty. The evidence of the sense, helped and guarded by a certain process of correction, I retain. But the mental operation which follows the act of sense I for the most part reject; and instead of it I open and lay out a new and certain path for the mind to proceed in, starting directly from the simple sensuous perception. The necessity of this was felt no doubt by those who attributed so much importance to Logic; showing thereby that they were in search of helps for the understanding, and had no confidence in the native and spontaneous process of the mind. But this remedy comes too late to do any good, when the mind is already, through the daily intercourse and conversation of life, occupied with unsound doctrines and beset on all sides by vain imaginations. And therefore that art of Logic, coming (as I said) too late to the rescue, and no way able to set matters right again, has had the effect of fixing errors rather than disclosing truth. There remains but one course for the recovery of a sound and healthy condition, — namely, that the entire work of the understanding be commenced afresh, and the mind itself be from the very outset not left to

take its own course, but guided at every step; and the business be done as if by machinery. Certainly if in things mechanical men had set to work with their naked hands, without help or force of instruments, just as in things intellectual they have set to work with little else than the naked forces of the understanding, very small would the matters have been which, even with their best efforts applied in conjunction, they could have attempted or accomplished. Now (to pause awhile upon this example and look in it as in a glass) let us suppose that some vast obelisk were (for the decoration of a triumph or some such magnificence) to be removed from its place, and that men should set to work upon it with their naked hands; would not any sober spectator think them mad? And if they should then send for more people, thinking that in that way they might manage it, would he not think them all the madder? And if they then proceeded to make a selection, putting away the weaker hands, and using only the strong and vigorous, would he not think them madder than ever? And if lastly, not content with this, they resolved to call in aid the art of athletics, and required all their men to come with hands, arms, and sinews well anointed and medicated according to the rules of art, would he not cry out that they were only taking pains to show a kind of method and discretion in their madness? Yet just so it is that men proceed in matters intellectual, — with just the same kind of mad effort and useless combination of forces, — when they hope great things either from the number and cooperation or from the excellency and acuteness of individual wits; yea, and when they endeavour by Logic (which may be considered as a kind of athletic art)

to strengthen the sinews of the understanding; and yet with all this study and endeavour it is apparent to any true judgment that they are but applying the naked intellect all the time; whereas in every great work to be done by the hand of man it is manifestly impossible, without instruments and machinery, either for the strength of each to be exerted or the strength of all to be united.

Upon these premises two things occur to me of which, that they may not be overlooked, I would have men reminded. First it falls out fortunately as I think for the allaying of contradictions and heart-burnings, that the honour and reverence due to the ancients remains untouched and undiminished; while I may carry out my designs and at the same time reap the fruit of my modesty. For if I should profess that I, going the same road as the ancients, have something better to produce, there must needs have been some comparison or rivalry between us (not to be avoided by any art of words) in respect of excellency or ability of wit; and though in this there would be nothing unlawful or new (for if there be anything misapprehended by them, or falsely laid down, why may not I, using a liberty common to all, take exception to it?) yet the contest, however just and allowable, would have been an unequal one perhaps, in respect of the measure of my own powers. As it is however, — my object being to open a new way for the understanding, a way by them untried and unknown, — the case is altered; party zeal and emulation are at an end; and I appear merely as a guide to point out the road; an office of small authority, and depending more upon a kind of luck than upon any ability or excellency. And thus much re-

lates to the persons only. The other point of which I would have men reminded relates to the matter itself.

Be it remembered then that I am far from wishing to interfere with the philosophy which now flourishes, or with any other philosophy more correct and complete than this which has been or may hereafter be propounded. For I do not object to the use of this received philosophy, or others like it, for supplying matter for disputations or ornaments for discourse, — for the professor's lecture and for the business of life. Nay more, I declare openly that for these uses the philosophy which I bring forward will not be much available. It does not lie in the way. It cannot be caught up in passage. It does not flatter the understanding by conformity with preconceived notions. Nor will it come down to the apprehension of the vulgar except by its utility and effects.

Let there be therefore (and may it be for the benefit of both) two streams and two dispensations of knowledge; and in like manner two tribes or kindreds of students in philosophy — tribes not hostile or alien to each other, but bound together by mutual services; — let there in short be one method for the cultivation, another for the invention, of knowledge.

And for those who prefer the former, either from hurry or from considerations of business or for want of mental power to take in and embrace the other (which must needs be most men's case), I wish that they may succeed to their desire in what they are about, and obtain what they are pursunig. But if any man there be who, not content to rest in and use the knowledge which has already been discovered, aspires to penetrate further; to overcome, not an adversary in argument,

but nature in action; to seek, not pretty and probable conjectures, but certain and demonstrable knowledge; — I invite all such to join themselves, as true sons of knowledge, with me, that passing by the outer courts of nature, which numbers have trodden, we may find a way at length into her inner chambers. And to make my meaning clearer and to familiarise the thing by giving it a name, I have chosen to call one of these methods or ways *Anticipation of the Mind*, the other *Interpretation of Nature*.

Moreover I have one request to make. I have on my own part made it my care and study that the things which I shall propound should not only be true, but should also be presented to men's minds, how strangely soever preoccupied and obstructed, in a manner not harsh or unpleasant. It is but reasonable however (especially in so great a restoration of learning and knowledge) that I should claim of men one favour in return; which is this; If any one would form an opinion or judgment either out of his own observation, or out of the crowd of authorities, or out of the forms of demonstration (which have now acquired a sanction like that of judicial laws), concerning these speculations of mine, let him not hope that he can do it in passage or by the by; but let him examine the thing thoroughly; let him make some little trial for himself of the way which I describe and lay out; let him familiarise his thoughts with that subtlety of nature to which experience bears witness; let him correct by seasonable patience and due delay the depraved and deep-rooted habits of his mind; and when all this is done and he has begun to be his own master, let him (if he will) use his own judgment.

APHORISMS.

APHORISMS

CONCERNING

THE INTERPRETATION OF NATURE

AND

THE KINGDOM OF MAN.

APHORISM

I.

MAN, being the servant and interpreter of Nature, can do and understand so much and so much only as he has observed in fact or in thought of the course of nature: beyond this he neither knows anything nor can do anything.

II.

Neither the naked hand nor the understanding left to itself can effect much. It is by instruments and helps that the work is done, which are as much wanted for the understanding as for the hand. And as the instruments of the hand either give motion or guide it, so the instruments of the mind supply either suggestions for the understanding or cautions.

III.

Human knowledge and human power meet in one; for where the cause is not known the effect cannot be

produced. Nature to be commanded must be obeyed; and that which in contemplation is as the cause is in operation as the rule.

IV.

Towards the effecting of works, all that man can do is to put together or put asunder natural bodies. The rest is done by nature working within.

V.

The study of nature with a view to works is engaged in by the mechanic, the mathematician, the physician, the alchemist, and the magician; but by all (as things now are) with slight endeavour and scanty success.

VI.

It would be an unsound fancy and self-contradictory to expect that things which have never yet been done can be done except by means which have never yet been tried.

VII.

The productions of the mind and hand seem very numerous in books and manufactures. But all this variety lies in an exquisite subtlety and derivations from a few things already known; not in the number of axioms.

VIII.

Moreover the works already known are due to chance and experiment rather than to sciences; for the sciences we now possess are merely systems for the nice ordering and setting forth of things already invented; not methods of invention or directions for new works.

IX.

The cause and root of nearly all evils in the sciences is this — that while we falsely admire and extol the powers of the human mind we neglect to seek for its true helps.

X.

The subtlety of nature is greater many times over than the subtlety of the senses and understanding; so that all those specious meditations, speculations, and glosses in which men indulge are quite from the purpose,[1] only there is no one by to observe it.

XI.

As the sciences which we now have do not help us in finding out new works, so neither does the logic which we now have help us in finding out new sciences.

XII.

The logic now in use serves rather to fix and give stability to the errors which have their foundation in commonly received notions than to help the search after truth. So it does more harm than good.

XIII.

The syllogism is not applied to the first principles of sciences, and is applied in vain to intermediate axioms; being no match for the subtlety of nature.

[1] Literally, "are a thing insane." The meaning appears to be, that these speculations, being founded upon such an inadequate conception of the case, must necessarily be so wide of the truth that they would seem like mere madness if we could only compare them with it: like the aim of a man blindfolded to bystanders looking on. — *J. S.*

It commands assent therefore to the proposition, but does not take hold of the thing.

XIV.

The syllogism consists of propositions, propositions consist of words, words are symbols of notions. Therefore if the notions themselves (which is the root of the matter) are confused and over-hastily abstracted from the facts, there can be no firmness in the superstructure. Our only hope therefore lies in a true induction.

XV.

There is no soundness in our notions whether logical or physical. Substance, Quality, Action, Passion, Essence itself, are not sound notions: much less are Heavy, Light, Dense, Rare, Moist, Dry, Generation, Corruption, Attraction, Repulsion, Element, Matter, Form, and the like; but all are fantastical and ill defined.

XVI.

Our notions of less general species, as Man, Dog, Dove, and of the immediate perceptions of the sense, as Hot, Cold, Black, White, do not materially mislead us; yet even these are sometimes confused by the flux and alteration of matter and the mixing of one thing with another. All the others which men have hitherto adopted are but wanderings, not being abstracted and formed from things by proper methods.

XVII.

Nor is there less of wilfulness and wandering in the construction of axioms than in the formations of notions; not excepting even those very principles which

are obtained by common induction; but much more in the axioms and lower propositions educed by the syllogism.

XVIII.

The discoveries which have hitherto been made in the sciences are such as lie close to vulgar notions, scarcely beneath the surface. In order to penetrate into the inner and further recesses of nature, it is necessary that both notions and axioms be derived from things by a more sure and guarded way; and that a method of intellectual operation be introduced altogether better and more certain.

XIX.

There are and can be only two ways of searching into and discovering truth. The one flies from the senses and particulars to the most general axioms, and from these principles, the truth of which it takes for settled and immoveable, proceeds to judgment and to the discovery of middle axioms. And this way is now in fashion. The other derives axioms from the senses and particulars, rising by a gradual and unbroken ascent, so that it arrives at the most general axioms last of all. This is the true way, but as yet untried.

XX.

The understanding left to itself takes the same course (namely, the former) which it takes in accordance with logical order. For the mind longs to spring up to positions of higher generality, that it may find rest there; and so after a little while wearies of experiment. But this evil is increased by logic, because of the order and solemnity of its disputations.

XXI.

The understanding left to itself, in a sober, patient, and grave mind, especially if it be not hindered by received doctrines, tries a little that other way, which is the right one, but with little progress; since the understanding, unless directed and assisted, is a thing unequal, and quite unfit to contend with the obscurity of things.

XXII.

Both ways set out from the senses and particulars, and rest in the highest generalities; but the difference between them is infinite. For the one just glances at experiment and particulars in passing, the other dwells duly and orderly among them. The one, again, begins at once by establishing certain abstract and useless generalities, the other rises by gradual steps to that which is prior and better known in the order of nature.

XXIII.

There is a great difference between the Idols of the human mind and the Ideas of the divine. That is to say, between certain empty dogmas, and the true signatures and marks set upon the works of creation as they are found in nature.

XXIV.

It cannot be that axioms established by argumentation should avail for the discovery of new works; since the subtlety of nature is greater many times over than the subtlety of argument. But axioms duly and orderly formed from particulars easily discover the way to new particulars, and thus render sciences active.

XXV.

The axioms now in use, having been suggested by a scanty and manipular experience and a few particulars of most general occurrence, are made for the most part just large enough to fit and take these in: and therefore it is no wonder if they do not lead to new particulars. And if some opposite instance, not observed or not known before, chance to come in the way, the axiom is rescued and preserved by some frivolous distinction; whereas the truer course would be to correct the axiom itself.

XXVI.

The conclusions of human reason as ordinarily applied in matter of nature, I call for the sake of distinction *Anticipations of Nature* (as a thing rash or premature). That reason which is elicited from facts by a just and methodical process, I call *Interpretation of Nature.*

XXVII.

Anticipations are a ground sufficiently firm for consent; for even if men went mad all after the same fashion, they might agree one with another well enough.

XXVIII.

For the winning of assent, indeed, anticipations are far more powerful than interpretations; because being collected from a few instances, and those for the most part of familiar occurrence, they straightway touch the understanding and fill the imagination; whereas interpretations on the other hand, being gathered here and there from very various and widely dispersed facts,

cannot suddenly strike the understanding; and therefore they must needs, in respect of the opinions of the time, seem harsh and out of tune; much as the mysteries of faith do.

XXIX.

In sciences founded on opinions and dogmas, the use of anticipations and logic is good; for in them the object is to command assent to the proposition, not to master the thing.

XXX.

Though all the wits of all the ages should meet together and combine and transmit their labours, yet will no great progress ever be made in science by means of anticipations; because radical errors in the first concoction of the mind are not to be cured by the excellence of functions and remedies subsequent.

XXXI.

It is idle to expect any great advancement in science from the superinducing and engrafting of new things upon old. We must begin anew from the very foundations, unless we would revolve for ever in a circle with mean and contemptible progress.

XXXII.

The honour of the ancient authors, and indeed of all, remains untouched; since the comparison I challenge is not of wits or faculties, but of ways and methods, and the part I take upon myself is not that of a judge, but of a guide.

XXXIII.

This must be plainly avowed: no judgment can be rightly formed either of my method or of the discoveries

to which it leads, by means of anticipations (that is to say, of the reasoning which is now in use); since I cannot be called on to abide by the sentence of a tribunal which is itself on its trial.

XXXIV.

Even to deliver and explain what I bring forward is no easy matter; for things in themselves new will yet be apprehended with reference to what is old.

XXXV.

It was said by Borgia of the expedition of the French into Italy, that they came with chalk in their hands to mark out their lodgings, not with arms to force their way in. I in like manner would have my doctrine enter quietly into the minds that are fit and capable of receiving it; for confutations cannot be employed, when the difference is upon first principles and very notions and even upon forms of demonstration.

XXXVI.

One method of delivery alone remains to us; which is simply this: we must lead men to the particulars themselves, and their series and order; while men on their side must force themselves for awhile to lay their notions by and begin to familiarise themselves with facts.

XXXVII.

The doctrine of those who have denied that certainty could be attained at all, has some agreement with my way of proceeding at the first setting out; but they end in being infinitely separated and opposed. For the holders of that doctrine assert simply that nothing can

be known; I also assert that not much can be known in nature by the way which is now in use. But then they go on to destroy the authority of the senses and understanding; whereas I proceed to devise and supply helps for the same.

XXXVIII.

The idols and false notions which are now in possession of the human understanding, and have taken deep root therein, not only so beset men's minds that truth can hardly find entrance, but even after entrance obtained, they will again in the very instauration of the sciences meet and trouble us, unless men being forewarned of the danger fortify themselves as far as may be against their assaults.

XXXIX.

There are four classes of Idols which beset men's minds. To these for distinction's sake I have assigned names, — calling the first class *Idols of the Tribe;* the second, *Idols of the Cave;* the third, *Idols of the Market-place;* the fourth, *Idols of the Theatre.*

XL.

The formation of ideas and axioms by true induction is no doubt the proper remedy to be applied for the keeping off and clearing away of idols. To point them out, however, is of great use; for the doctrine of Idols is to the Interpretation of Nature what the doctrine of the refutation of Sophisms is to common Logic.

XLI.

The Idols of the Tribe have their foundation in hu-

man nature itself, and in the tribe or race of men. For it is a false assertion that the sense of man is the measure of things. On the contrary, all perceptions as well of the sense as of the mind are according to the measure of the individual and not according to the measure of the universe. And the human understanding is like a false mirror, which, receiving rays irregularly, distorts and discolours the nature of things by mingling its own nature with it.

XLII.

The Idols of the Cave are the idols of the individual man. For every one (besides the errors common to human nature in general) has a cave or den of his own, which refracts and discolours the light of nature; owing either to his own proper and peculiar nature; or to his education and conversation with others; or to the reading of books, and the authority of those whom he esteems and admires; or to the differences of impressions, accordingly as they take place in a mind preoccupied and predisposed or in a mind indifferent and settled; or the like. So that the spirit of man (according as it is meted out to different individuals [1]) is in fact a thing variable and full of perturbation, and governed as it were by chance. Whence it was well observed by Heraclitus that men look for sciences in their own lesser worlds, and not in the greater or common world.

[1] This was Mr. Ellis's translation of *prout disponitur in hominibus singulis;* supposing Bacon to allude to Averroës's doctrine of one intellect, whereof each man has an undivided share. I should myself have understood *disponitur* as referring to the disposition of the parts of the spirit in itself, not to the distribution of it in different persons; as in the expression *well disposed, ill disposed,* &c. — *J. S.*

XLIII.

There are also Idols formed by the intercourse and association of men with each other, which I call Idols of the Market-place, on account of the commerce and consort of men there. For it is by discourse that men associate; and words are imposed according to the apprehension of the vulgar. And therefore the ill and unfit choice of words wonderfully obstructs the understanding. Nor do the definitions or explanations wherewith in some things learned men are wont to guard and defend themselves, by any means set the matter right. But words plainly force and overrule the understanding, and throw all into confusion, and lead men away into numberless empty controversies and idle fancies.

XLIV.

Lastly, there are Idols which have immigrated into men's minds from the various dogmas of philosophies, and also from wrong laws of demonstration. These I call Idols of the Theatre; because in my judgment all the received systems are but so many stage-plays, representing worlds of their own creation after an unreal and scenic fashion. Nor is it only of the systems now in vogue, or only of the ancient sects and philosophies, that I speak; for many more plays of the same kind may yet be composed and in like artificial manner set forth; seeing that errors the most widely different have nevertheless causes for the most part alike. Neither again do I mean this only of entire systems, but also of many principles and axioms in science, which by tradition, credulity, and negligence have come to be received.

But of these several kinds of Idols I must speak more largely and exactly, that the understanding may be duly cautioned.

XLV.

The human understanding is of its own nature prone to suppose the existence of more order and regularity in the world than it finds. And though there be many things in nature which are singular and unmatched, yet it devises for them parallels and conjugates and relatives which do not exist. Hence the fiction that all celestial bodies move in perfect circles; spirals and dragons being (except in name) utterly rejected. Hence too the element of Fire with its orb is brought in, to make up the square with the other three which the sense perceives. Hence also the ratio of density of the so-called elements is arbitrarily fixed at ten to one. And so on of other dreams. And these fancies affect not dogmas only, but simple notions also.

XLVI.

The human understanding when it has once adopted an opinion (either as being the received opinion or as being agreeable to itself) draws all things else to support and agree with it. And though there be a greater number and weight of instances to be found on the other side, yet these it either neglects and despises, or else by some distinction sets aside and rejects; in order that by this great and pernicious predetermination [1] the authority of its former conclusions may remain inviolate. And therefore it was a good answer that was made by one who when they showed him hanging in a

[1] Rather perhaps "prejudging the matter to a great and pernicious extent, in order that," &c. (*non sine magno et pernicioso præjudicio, quo, &c.*) —*J. S.*

temple a picture of those who had paid their vows as having escaped shipwreck, and would have him say whether he did not now acknowledge the power of the gods, — "Aye," asked he again, "but where are they painted that were drowned after their vows?" And such is the way of all superstition, whether in astrology, dreams, omens, divine judgments, or the like; wherein men, having a delight in such vanities, mark the events where they are fulfilled, but where they fail, though this happen much oftener, neglect and pass them by. But with far more subtlety does this mischief insinuate itself into philosophy and the sciences; in which the first conclusion colours and brings into conformity with itself all that come after, though far sounder and better. Besides, independently of that delight and vanity which I have described, it is the peculiar and perpetual error of the human intellect to be more moved and excited by affirmatives than by negatives; whereas it ought properly to hold itself indifferently disposed towards both alike. Indeed in the establishment of any true axiom, the negative instance is the more forcible of the two.

XLVII.

The human understanding is moved by those things most which strike and enter the mind simultaneously and suddenly, and so fill the imagination; and then it feigns and supposes all other things to be somehow, though it cannot see how, similar to those few things by which it is surrounded. But for that going to and fro to remote and heterogeneous instances, by which axioms are tried as in the fire, the intellect is altogether slow and unfit, unless it be forced thereto by severe laws and overruling authority.

XLVIII.

The human understanding is unquiet; it cannot stop or rest, and still presses onward, but in vain. Therefore it is that we cannot conceive of any end or limit to the world; but always as of necessity it occurs to us that there is something beyond. Neither again can it be conceived how eternity has flowed down to the present day; for that distinction which is commonly received of infinity in time past and in time to come can by no means hold; for it would thence follow that one infinity is greater than another, and that infinity is wasting away and tending to become finite. The like subtlety arises touching the infinite divisibility of lines, from the same inability of thought to stop. But this inability interferes more mischievously in the discovery of causes: for although the most general principles in nature ought to be held merely positive, as they are discovered, and cannot with truth be referred to a cause; nevertheless the human understanding being unable to rest still seeks something prior in the order of nature. And then it is that in struggling towards that which is further off it falls back upon that which is more nigh at hand; namely, on final causes: which have relation clearly to the nature of man rather than to the nature of the universe; and from this source have strangely defiled philosophy. But he is no less an unskilled and shallow philosopher who seeks causes of that which is most general, than he who in things subordinate and subaltern omits to do so.

XLIX.

The human understanding is no dry light, but receives an infusion from the will and affections; whence proceed sciences which may be called "sciences as one would." For what a man had rather were true he more readily believes. Therefore he rejects difficult things from impatience of research; sober things, because they narrow hope; the deeper things of nature, from superstition; the light of experience, from arrogance and pride, lest his mind should seem to be occupied with things mean and transitory; things not commonly believed, out of deference to the opinion of the vulgar. Numberless in short are the ways, and sometimes imperceptible, in which the affections colour and infect the understanding.

L.

But by far the greatest hindrance and aberration of the human understanding proceeds from the dulness, incompetency, and deceptions of the senses; in that things which strike the sense outweigh things which do not immediately strike it, though they be more important. Hence it is that speculation commonly ceases where sight ceases; insomuch that of things invisible there is little or no observation. Hence all the working of the spirits inclosed in tangible bodies lies hid and unobserved of men. So also all the more subtle changes of form in the parts of coarser substances (which they commonly call alteration, though it is in truth local motion through exceedingly small spaces) is in like manner unobserved. And yet unless these two things just mentioned be searched out and

brought to light, nothing great can be achieved in nature, as far as the production of works is concerned. So again the essential nature of our common air, and of all bodies less dense than air (which are very many), is almost unknown. For the sense by itself is a thing infirm and erring; neither can instruments for enlarging or sharpening the senses do much; but all the truer kind of interpretation of nature is effected by instances and experiments fit and apposite; wherein the sense decides touching the experiment only, and the experiment touching the point in nature and the thing itself.

LI.

The human understanding is of its own nature prone to abstractions and gives a substance and reality to things which are fleeting. But to resolve nature into abstractions is less to our purpose than to dissect her into parts; as did the school of Democritus, which went further into nature than the rest. Matter rather than forms should be the object of our attention, its configurations and changes of configuration, and simple action, and law of action or motion; for forms are figments of the human mind, unless you will call those laws of action forms.

LII.

Such then are the idols which I call *Idols of the Tribe;* and which take their rise either from the homogeneity of the substance of the human spirit, or from its preoccupation, or from its narrowness, or from its restless motion, or from an infusion of the affections, or from the incompetency of the senses, or from the mode of impression.

LIII.

The *Idols of the Cave* take their rise in the peculiar constitution, mental or bodily, of each individual; and also in education, habit, and accident. Of this kind there is a great number and variety; but I will instance those the pointing out of which contains the most important caution, and which have most effect in disturbing the clearness of the understanding.

LIV.

Men become attached to certain particular sciences and speculations, either because they fancy themselves the authors and inventors thereof, or because they have bestowed the greatest pains upon them and become most habituated to them. But men of this kind, if they betake themselves to philosophy and contemplations of a general character, distort and colour them in obedience to their former fancies; a thing especially to be noticed in Aristotle, who made his natural philosophy a mere bond-servant to his logic, thereby rendering it contentious and well nigh useless. The race of chemists again out of a few experiments of the furnace have built up a fantastic philosophy, framed with reference to a few things; and Gilbert also, after he had employed himself most laboriously in the study and observation of the loadstone, proceeded at once to construct an entire system in accordance with his favourite subject.

LV.

There is one principal and as it were radical distinction between different minds, in respect of philosophy and the sciences; which is this: that some minds are

stronger and apter to mark the differences of things, others to mark their resemblances. The steady and acute mind can fix its contemplations and dwell and fasten on the subtlest distinctions: the lofty and discursive mind recognises and puts together the finest and most general resemblances. Both kinds however easily err in excess, by catching the one at gradations the other at shadows.

LVI.

There are found some minds given to an extreme admiration of antiquity, others to an extreme love and appetite for novelty; but few so duly tempered that they can hold the mean, neither carping at what has been well laid down by the ancients, nor despising what is well introduced by the moderns. This however turns to the great injury of the sciences and philosophy; since these affectations of antiquity and novelty are the humours of partisans rather than judgments; and truth is to be sought for not in the felicity of any age, which is an unstable thing, but in the light of nature and experience, which is eternal. These factions therefore must be abjured, and care must be taken that the intellect be not hurried by them into assent.

LVII.

Contemplations of nature and of bodies in their simple form break up and distract the understanding, while contemplations of nature and bodies in their composition and configuration overpower and dissolve the understanding: a distinction well seen in the school of Leucippus and Democritus as compared with the other philosophies. For that school is so busied with

the particles that it hardly attends to the structure; while the others are so lost in admiration of the structure that they do not penetrate to the simplicity of nature. These kinds of contemplation should therefore be alternated and taken by turns; that so the understanding may be rendered at once penetrating and comprehensive, and the inconveniences above mentioned, with the idols which proceed from them, may be avoided.

LVIII.

Let such then be our provision and contemplative prudence for keeping off and dislodging the *Idols of the Cave*, which grow for the most part either out of the predominance of a favourite subject, or out of an excessive tendency to compare or to distinguish, or out of partiality for particular ages, or out of the largeness or minuteness of the objects contemplated. And generally let every student of nature take this as a rule, — that whatever his mind seizes and dwells upon with peculiar satisfaction is to be held in suspicion, and that so much the more care is to be taken in dealing with such questions to keep the understanding even and clear.

LIX.

But the *Idols of the Market-place* are the most troublesome of all: idols which have crept into the understanding through the alliances of words and names. For men believe that their reason governs words; but it is also true that words react on the understanding; and this it is that has rendered philosophy and the sciences sophistical and inactive. Now words, being commonly framed and applied according to the capacity of the vulgar, follow those lines of division which are

most obvious to the vulgar understanding. And whenever an understanding of greater acuteness or a more diligent observation would alter those lines to suit the true divisions of nature, words stand in the way and resist the change. Whence it comes to pass that the high and formal discussions of learned men end oftentimes in disputes about words and names; with which (according to the use and wisdom of the mathematicians) it would be more prudent to begin, and so by means of definitions reduce them to order. Yet even definitions cannot cure this evil in dealing with natural and material things; since the definitions themselves consist of words, and those words beget others: so that it is necessary to recur to individual instances, and those in due series and order; as I shall say presently when I come to the method and scheme for the formation of notions and axioms.

LX.

The idols imposed by words on the understanding are of two kinds. They are either names of things which do not exist (for as there are things left unnamed through lack of observation, so likewise are there names which result from fantastic suppositions and to which nothing in reality corresponds), or they are names of things which exist, but yet confused and ill-defined, and hastily and irregularly derived from realities. Of the former kind are Fortune, the Prime Mover, Planetary Orbits, Element of Fire, and like fictions which owe their origin to false and idle theories. And this class of idols is more easily expelled, because to get rid of them it is only necessary that all theories should be steadily rejected and dismissed as obsolete.

But the other class, which springs out of a faulty and unskilful abstraction, is intricate and deeply rooted. Let us take for example such a word as *humid;* and see how far the several things which the word is used to signify agree with each other; and we shall find the word *humid* to be nothing else than a mark loosely and confusedly applied to denote a variety of actions which will not bear to be reduced to any constant meaning. For it both signifies that which easily spreads itself round any other body; and that which in itself is indeterminate and cannot solidise; and that which readily yields in every direction; and that which easily divides and scatters itself; and that which easily unites and collects itself; and that which readily flows and is put in motion; and that which readily clings to another body and wets it; and that which is easily reduced to a liquid, or being solid easily melts. Accordingly when you come to apply the word, — if you take it in one sense, flame is humid; if in another, air is not humid; if in another, fine dust is humid; if in another, glass is humid. So that it is easy to see that the notion is taken by abstraction only from water and common and ordinary liquids, without any due verification.

There are however in words certain degrees of distortion and error. One of the least faulty kinds is that of names of substances, especially of lowest species and well-deduced (for the notion of *chalk* and of *mud* is good, of *earth* bad); a more faulty kind is that of actions, as *to generate, to corrupt, to alter;* the most faulty is of qualities (except such as are the immediate objects of the sense) as *heavy, light, rare, dense*, and the like. Yet in all these cases some notions are of necessity a little better than others, in proportion to the greater

variety of subjects that fall within the range of the human sense.

LXI.

But the *Idols of the Theatre* are not innate, nor do they steal into the understanding secretly, but are plainly impressed and received into the mind from the play-books of philosophical systems and the perverted rules of demonstration. To attempt refutations in this case would be merely inconsistent with what I have already said: for since we agree neither upon principles nor upon demonstrations there is no place for argument. And this is so far well, inasmuch as it leaves the honour of the ancients untouched. For they are no wise disparaged — the question between them and me being only as to the way. For as the saying is, the lame man who keeps the right road outstrips the runner who takes a wrong one. Nay it is obvious that when a man runs the wrong way, the more active and swift he is the further he will go astray.

But the course I propose for the discovery of sciences is such as leaves but little to the acuteness and strength of wits, but places all wits and understandings nearly on a level. For as in the drawing of a straight line or a perfect circle, much depends on the steadiness and practice of the hand, if it be done by aim of hand only, but if with the aid of rule or compass, little or nothing; so is it exactly with my plan. But though particular confutations would be of no avail, yet touching the sects and general divisions of such systems I must say something; something also touching the external signs which show that they are unsound; and finally something touching the causes of such great infelicity and of such lasting and general agreement in error; that so the

access to truth may be made less difficult, and the human understanding may the more willingly submit to its purgation and dismiss its idols.

LXII.

Idols of the Theatre, or of Systems, are many, and there can be and perhaps will be yet many more. For were it not that now for many ages men's minds have been busied with religion and theology; and were it not that civil governments, especially monarchies, have been averse to such novelties, even in matters speculative; so that men labour therein to the peril and harming of their fortunes, — not only unrewarded, but exposed also to contempt and envy; doubtless there would have arisen many other philosophical sects like to those which in great variety flourished once among the Greeks. For as on the phenomena of the heavens many hypotheses may be constructed, so likewise (and more also) many various dogmas may be set up and established on the phenomena of philosophy. And in the plays of this philosophical theatre you may observe the same thing which is found in the theatre of the poets, that stories invented for the stage are more compact and elegant, and more as one would wish them to be, than true stories out of history.

In general however there is taken for the material of philosophy either a great deal out of a few things, or a very little out of many things; so that on both sides philosophy is based on too narrow a foundation of experiment and natural history, and decides on the authority of too few cases. For the Rational School of philosophers snatches from experience a variety of common instances, neither duly ascertained nor diligently

examined and weighed, and leaves all the rest to meditation and agitation of wit.

There is also another class of philosophers, who having bestowed much diligent and careful labour on a few experiments, have thence made bold to educe and construct systems; wresting all other facts in a strange fashion to conformity therewith.

And there is yet a third class, consisting of those who out of faith and veneration mix their philosophy with theology and traditions; among whom the vanity of some has gone so far aside as to seek the origin of sciences among spirits and genii. So that this parent stock of errors — this false philosophy — is of three kinds; the Sophistical, the Empirical, and the Superstitious.

LXIII.

The most conspicuous example of the first class was Aristotle, who corrupted natural philosophy by his logic: fashioning the world out of categories; assigning to the human soul, the noblest of substances, a genus from words of the second intention; doing the business of density and rarity (which is to make bodies of greater or less dimensions, that is, occupy greater or less spaces), by the frigid distinction of act and power; asserting that single bodies have each a single and proper motion, and that if they participate in any other, then this results from an external cause; and imposing countless other arbitrary restrictions on the nature of things; being always more solicitous to provide an answer to the question and affirm something positive in words, than about the inner truth of things; a failing best shown when his philosophy is compared with other systems of note among the Greeks. For the Homœ-

omera of Anaxagoras; the Atoms of Leucippus and Democritus; the Heaven and Earth of Parmenides; the Strife and Friendship of Empedocles; Heraclitus's doctrine how bodies are resolved into the indifferent nature of fire, and remoulded into solids; have all of them some taste of the natural philosopher, — some savour of the nature of things, and experience, and bodies; whereas in the physics of Aristotle you hear hardly anything but the words of logic; which in his metaphysics also, under a more imposing name, and more forsooth as a realist than a nominalist, he has handled over again. Nor let any weight be given to the fact, that in his books on animals and his problems, and other of his treatises, there is frequent dealing with experiments. For he had come to his conclusion before; he did not consult experience, as he should have done, in order to the framing of his decisions and axioms; but having first determined the question according to his will, he then resorts to experience, and bending her into conformity with his placets leads her about like a captive in a procession; so that even on this count he is more guilty than his modern followers, the schoolmen, who have abandoned experience altogether.

LXIV.

But the Empirical school of philosophy gives birth to dogmas more deformed and monstrous than the Sophistical or Rational school. For it has its foundations not in the light of common notions, (which though it be a faint and superficial light, is yet in a manner universal, and has reference to many things,[1]) but in the narrow-

[1] *Ad multa pertinens.* In the formation of such notions many things have been taken into account. — *J. S.*

ness and darkness of a few experiments. To those therefore who are daily busied with these experiments, and have infected their imagination with them, such a philosophy seems probable and all but certain; to all men else incredible and vain. Of this there is a notable instance in the alchemists and their dogmas; though it is hardly to be found elsewhere in these times, except perhaps in the philosophy of Gilbert. Nevertheless with regard to philosophies of this kind there is one caution not to be omitted; for I foresee that if ever men are roused by my admonitions to betake themselves seriously to experiment and bid farewell to sophistical doctrines, then indeed through the premature hurry of the understanding to leap or fly to universals and principles of things, great danger may be apprehended from philosophies of this kind; against which evil we ought even now to prepare.

LXV.

But the corruption of philosophy by superstition and an admixture of theology is far more widely spread, and does the greatest harm, whether to entire systems or to their parts. For the human understanding is obnoxious to the influence of the imagination no less than to the influence of common notions. For the contentious and sophistical kind of philosophy ensnares the understanding; but this kind, being fanciful and tumid and half poetical, misleads it more by flattery. For there is in man an ambition of the understanding, no less than of the will, especially in high and lofty spirits.

Of this kind we have among the Greeks a striking example in Pythagoras, though he united with it a

coarser and more cumbrous superstition; another in Plato and his school, more dangerous and subtle. It shows itself likewise in parts of other philosophies, in the introduction of abstract forms and final causes and first causes, with the omission in most cases of causes intermediate, and the like. Upon this point the greatest caution should be used. For nothing is so mischievous as the apotheosis of error; and it is a very plague of the understanding for vanity to become the object of veneration. Yet in this vanity some of the moderns have with extreme levity indulged so far as to attempt to found a system of natural philosophy on the first chapter of Genesis, on the book of Job, and other parts of the sacred writings; seeking for the dead among the living: which also makes the inhibition and repression of it the more important, because from this unwholesome mixture of things human and divine there arises not only a fantastic philosophy but also an heretical religion. Very meet it is therefore that we be sober-minded, and give to faith that only which is faith's.

LXVI.

So much then for the mischievous authorities of systems, which are founded either on common notions, or on a few experiments, or on superstition. It remains to speak of the faulty subject-matter of contemplations, especially in natural philosophy. Now the human understanding is infected by the sight of what takes place in the mechanical arts, in which the alteration of bodies proceeds chiefly by composition or separation, and so imagines that something similar goes on in the universal nature of things. From this source has flowed the fiction of elements, and of their concourse for the for-

mation of natural bodies. Again, when man contemplates nature working freely, he meets with different species of things, of animals, of plants, of minerals; whence he readily passes into the opinion that there are in nature certain primary forms which nature intends to educe, and that the remaining variety proceeds from hindrances and aberrations of nature in the fulfilment of her work, or from the collision of different species and the transplanting of one into another. To the first of these speculations we owe our primary qualities of the elements; to the other our occult properties and specific virtues; and both of them belong to those empty *compendia* of thought wherein the mind rests, and whereby it is diverted from more solid pursuits. It is to better purpose that the physicians bestow their labour on the secondary qualities of matter, and the operations of attraction, repulsion, attenuation, conspissation, dilatation, astriction, dissipation, maturation, and the like; and were it not that by those two compendia which I have mentioned (elementary qualities, to wit, and specific virtues) they corrupted their correct observations in these other matters, — either reducing them to first qualities and their subtle and incommensurable mixtures, or not following them out with greater and more diligent observation to third and fourth qualities, but breaking off the scrutiny prematurely, — they had made much greater progress. Nor are powers of this kind (I do not say the same, but similar) to be sought for only in the medicines of the human body, but also in the changes of all other bodies.

But it is a far greater evil that they make the quiescent principles, *wherefrom*, and not the moving principles, *whereby*, things are produced, the object of their

contemplation and inquiry. For the former tend to discourse, the latter to works. Nor is there any value in those vulgar distinctions of motion which are observed in the received system of natural philosophy, as generation, corruption, augmentation, diminution, alteration, and local motion. What they mean no doubt is this: — If a body in other respects not changed, be moved from its place, *this is local motion;* if without change of place or essence, it be changed in quality, this is *alteration;* if by reason of the change the mass and quantity of the body do not remain the same, this is *augmentation* or *diminution;* if they be changed to such a degree that they change their very essence and substance and turn to something else, this is *generation* and *corruption.* But all this is merely popular, and does not at all go deep into nature; for these are only measures and limits, not kinds of motion. What they intimate is *how far*, not *by what means*, or *from what source.* For they do not suggest anything with regard either to the desires of bodies or to the development of their parts: it is only when that motion presents the thing grossly and palpably to the sense as different from what it was, that they begin to mark the division. Even when they wish to suggest something with regard to the causes of motion, and to establish a division with reference to them, they introduce with the greatest negligence a distinction between motion natural and violent; a distinction which is itself drawn entirely from a vulgar notion, since all violent motion is also in fact natural; the external efficient simply setting nature working otherwise than it was before. But if, leaving all this, any one shall observe (for instance) that there is in bodies a desire of mutual contact, so as

not to suffer the unity of nature to be quite separated or broken and a vacuum thus made; or if any one say that there is in bodies a desire of resuming their natural dimensions or tension, so that if compressed within or extended beyond them, they immediately strive to recover themselves, and fall back to their old volume and extent; or if any one say that there is in bodies a desire of congregating towards masses of kindred nature, — of dense bodies, for instance, towards the globe of the earth, of thin and rare bodies towards the compass of the sky; all these and the like are truly physical kinds of motion; — but those others are entirely logical and scholastic, as is abundantly manifest from this comparison.

Nor again is it a less evil, that in their philosophies and contemplations their labour is spent in investigating and handling the first principles of things and the highest generalities of nature; whereas utility and the means of working result entirely from things intermediate. Hence it is that men cease not from abstracting nature till they come to potential and uninformed matter, nor on the other hand from dissecting nature till they reach the atom; things which, even if true, can do but little for the welfare of mankind.

LXVII.

A caution must also be given to the understanding against the intemperance which systems of philosophy manifest in giving or withholding assent; because intemperance of this kind seems to establish Idols and in some sort to perpetuate them, leaving no way open to reach and dislodge them.

This excess is of two kinds: the first being manifest

in those who are ready in deciding, and render sciences dogmatic and magisterial; the other in those who deny that we can know anything, and so introduce a wandering kind of inquiry that leads to nothing; of which kinds the former subdues, the latter weakens the understanding. For the philosophy of Aristotle, after having by hostile confutations destroyed all the rest (as the Ottomans serve their brothers), has laid down the law on all points; which done, he proceeds himself to raise new questions of his own suggestion, and dispose of them likewise; so that nothing may remain that is not certain and decided: a practice which holds and is in use among his successors.

The school of Plato, on the other hand, introduced *Acatalepsia*, at first in jest and irony, and in disdain of the older sophists, Protagoras, Hippias, and the rest, who were of nothing else so much ashamed as of seeming to doubt about anything. But the New Academy made a dogma of it, and held it as a tenet. And though their's is a fairer seeming way than arbitrary decisions; since they say that they by no means destroy all investigation, like Pyrrho and his Refrainers, but allow of some things to be followed as probable, though of none to be maintained as true; yet still when the human mind has once despaired of finding truth, its interest in all things grows fainter; and the result is that men turn aside to pleasant disputations and discourses and roam as it were from object to object, rather than keep on a course of severe inquisition. But, as I said at the beginning and am ever urging, the human senses and understanding, weak as they are, are not to be deprived of their authority, but to be supplied with helps.

LXVIII.

So much concerning the several classes of Idols, and their equipage: all of which must be renounced and put away with a fixed and solemn determination, and the understanding thoroughly freed and cleansed; the entrance into the kingdom of man, founded on the sciences, being not much other than the entrance into the kingdom of heaven, whereinto none may enter except as a little child.

LXIX.

But vicious demonstrations are as the strongholds and defences of Idols; and those we have in logic do little else than make the world the bond-slave of human thought, and human thought the bond-slave of words. Demonstrations truly are in effect the philosophies themselves and the sciences. For such as *they* are, well or ill established, such are the systems of philosophy and the contemplations which follow. Now in the whole of the process which leads from the sense and objects to axioms and conclusions, the demonstrations which we use are deceptive and incompetent. This process consists of four parts, and has as many faults. In the first place, the impressions of the sense itself are faulty; for the sense both fails us and deceives us. But its shortcomings are to be supplied, and its deceptions to be corrected. Secondly, notions are ill drawn from the impressions of the senses, and are indefinite and confused, whereas they should be definite and distinctly bounded. Thirdly, the induction is amiss which infers the principles of sciences by simple enumeration, and does not, as it ought, employ exclusions and solutions (or separations) of nature. Lastly,

that method of discovery and proof according to which the most general principles are first established, and then intermediate axioms are tried and proved by them, is the parent of error and the curse of all science. Of these things however, which now I do but touch upon, I will speak more largely, when, having performed these expiations and purgings of the mind, I come to set forth the true way for the interpretation of nature.

LXX.

But the best demonstration by far is experience, if it go not beyond the actual experiment. For if it be transferred to other cases which are deemed similar, unless such transfer be made by a just and orderly process, it is a fallacious thing. But the manner of making experiments which men now use is blind and stupid. And therefore, wandering and straying as they do with no settled course, and taking counsel only from things as they fall out, they fetch a wide circuit and meet with many matters, but make little progress; and sometimes are full of hope, sometimes are distracted; and always find that there is something beyond to be sought. For it generally happens that men make their trials carelessly, and as it were in play; slightly varying experiments already known, and, if the thing does not answer, growing weary and abandoning the attempt. And even if they apply themselves to experiments more seriously and earnestly and laboriously, still they spend their labour in working out some one experiment, as Gilbert with the magnet, and the chemists with gold; a course of proceeding not less unskilful in the design than small in the attempt. For no one successfully investigates the nature of a thing

in the thing itself; the inquiry must be enlarged, so as to become more general.

And even when they seek to educe some science or theory from their experiments, they nevertheless almost always turn aside with overhasty and unseasonable eagerness to practice; not only for the sake of the uses and fruits of the practice, but from impatience to obtain in the shape of some new work an assurance for themselves that it is worth their while to go on; and also to show themselves off to the world, and so raise the credit of the business in which they are engaged. Thus, like Atalanta, they go aside to pick up the golden apple, but meanwhile they interrupt their course, and let the victory escape them. But in the true course of experience, and in carrying it on to the effecting of new works, the divine wisdom and order must be our pattern. Now God on the first day of creation created light only, giving to that work an entire day, in which no material substance was created. So must we likewise from experience of every kind first endeavour to discover true causes and axioms; and seek for experiments of Light, not for experiments of Fruit. For axioms rightly discovered and established supply practice with its instruments, not one by one, but in clusters, and draw after them trains and troops of works. Of the paths however of experience, which no less than the paths of judgment are impeded and beset, I will speak hereafter; here I have only mentioned ordinary experimental research as a bad kind of demonstration. But now the order of the matter in hand leads me to add something both as to those *signs* which I lately mentioned,—(signs that the systems of philosophy and contemplation in use

are in a bad condition) — and also as to the *causes* of what seems at first so strange and incredible. For a knowledge of the signs prepares assent; an explanation of the causes removes the marvel: which two things will do much to render the extirpation of Idols from the understanding more easy and gentle.

LXXI.

The sciences which we possess come for the most part from the Greeks. For what has been added by Roman, Arabic, or later writers is not much nor of much importance; and whatever it is, it is built on the foundation of Greek discoveries. Now the wisdom of the Greeks was professorial and much given to disputations; a kind of wisdom most adverse to the inquisition of truth. Thus that name of Sophists, which by those who would be thought philosophers was in contempt cast back upon and so transferred to the ancient rhetoricians, Gorgias, Protagoras, Hippias, Polus, does indeed suit the entire class, Plato, Aristotle, Zeno, Epicurus, Theophrastus, and their successors Chrysippus, Carnades, and the rest. There was this difference only, that the former class was wandering and mercenary, going about from town to town, putting up their wisdom to sale, and taking a price for it; while the latter was more pompous and dignified, as composed of men who had fixed abodes, and who opened schools and taught their philosophy without reward. Still both sorts, though in other respects unequal, were professorial; both turned the matter into disputations, and set up and battled for philosophical sects and heresies; so that their doctrines were for the most part (as Dionysius not unaptly rallied

Plato) "the talk of idle old men to ignorant youths." But the elder of the Greek philosophers, Empedocles, Anaxagoras, Leucippus, Democritus, Parmenides, Heraclitus, Xenophanes, Philolaus, and the rest (I omit Pythagoras as a mystic), did not, so far as we know, open schools; but more silently and severely and simply, — that is, with less affectation and parade, — be took themselves to the inquisition of truth. And therefore they were in my judgment more successful; only that their works were in the course of time obscured by those slighter persons who had more which suits and pleases the capacity and tastes of the vulgar: time, like a river, bringing down to us things which are light and puffed up, but letting weighty matters sink. Still even they were not altogether free from the failing of their nation; but leaned too much to the ambition and vanity of founding a sect and catching popular applause. But the inquisition of truth must be despaired of when it turns aside to trifles of this kind. Nor should we omit that judgment, or rather divination, which was given concerning the Greeks by the Ægyptian priest, — that "they were always boys, without antiquity of knowledge or knowledge of antiquity." Assuredly they have that which is characteristic of boys; they are prompt to prattle, but cannot generate; for their wisdom abounds in words but is barren of works. And therefore the signs which are taken from the origin and birth-place of the received philosophy are not good.

LXXII.

Nor does the character of the time and age yield much better signs than the character of the country

and nation. For at that period there was but a narrow and meagre knowledge either of time or place; which is the worst thing that can be, especially for those who rest all on experience. For they had no history, worthy to be called history, that went back a thousand years; but only fables and rumours of antiquity. And of the regions and districts of the world they knew but a small portion; giving indiscriminately the name of Scythians to all in the North, of Celts to all in the West; knowing nothing of Africa beyond the hither side of Æthiopia, of Asia beyond the Ganges; much less were they acquainted with the provinces of the New World, even by hearsay or any well-founded rumour; nay, a multitude of climates and zones, wherein innumerable nations breathe and live, were pronounced by them to be uninhabitable; and the travels of Democritus, Plato, and Pythagoras, which were rather suburban excursions than distant journeys, were talked of as something great. In our times on the other hand both many parts of the New World and the limits on every side of the Old World are known, and our stock of experience has increased to an infinite amount. Wherefore if (like astrologers) we draw signs from the season of their nativity or birth, nothing great can be predicted of those systems of philosophy.

LXXIII.

Of all signs there is none more certain or more noble than that taken from fruits. For fruits and works are as it were sponsors and sureties for the truth of philosophies. Now, from all these systems of the Greeks, and their ramifications through particular sciences,

there can hardly after the lapse of so many years be adduced a single experiment which tends to relieve and benefit the condition of man, and which can with truth be referred to the speculations and theories of philosophy. And Celsus ingenuously and wisely owns as much, when he tells us that the experimental part of medicine was first discovered, and that afterwards men philosophised about it, and hunted for and assigned causes; and not by an inverse process that philosophy and the knowledge of causes led to the discovery and development of the experimental part. And therefore it was not strange that among the Ægyptians, who rewarded inventors with divine honours and sacred rites, there were more images of brutes than of men; inasmuch as brutes by their natural instinct have produced many discoveries, whereas men by discussion and the conclusions of reason have given birth to few or none.

Some little has indeed been produced by the industry of chemists; but it has been produced accidentally and in passing, or else by a kind of variation of experiments, such as mechanics use; and not by any art or theory; for the theory which they have devised rather confuses the experiments than aids them. They too who have busied themselves with natural magic, as they call it, have but few discoveries to show, and those trifling and imposture-like. Wherefore, as in religion we are warned to show our faith by works, so in philosophy by the same rule the system should be judged of by its fruits, and pronounced frivolous if it be barren; more especially if, in place of fruits of grape and olive, it bear thorns and briars of dispute and contention.

LXXIV.

Signs also are to be drawn from the increase and progress of systems and sciences. For what is founded on nature grows and increases; while what is founded on opinion varies but increases not. If therefore those doctrines had not plainly been like a plant torn up from its roots, but had remained attached to the womb of nature and continued to draw nourishment from her, that could never have come to pass which we have seen now for twice a thousand years; namely, that the sciences stand where they did and remain almost in the same condition; receiving no noticeable increase, but on the contrary, thriving most under their first founder, and then declining. Whereas in the mechanical arts, which are founded on nature and the light of experience, we see the contrary happen, for these (as long as they are popular) are continually thriving and growing, as having in them a breath of life; at first rude, then convenient, afterwards adorned, and at all times advancing.

LXXV.

There is still another sign remaining (if sign it can be called, when it is rather testimony, nay, of all testimony the most valid); I mean the confession of the very authorities whom men now follow. For even they who lay down the law on all things so confidently, do still in their more sober moods fall to complaints of the subtlety of nature, the obscurity of things, and the weakness of the human mind. Now if this were all they did, some perhaps of a timid disposition might be deterred from further search, while others of a more ardent and hopeful spirit might be whetted and incited

to go on farther. But not content to speak for themselves, whatever is beyond their own or their master's knowledge or reach they set down as beyond the bounds of possibility, and pronounce, as if on the authority of their art, that it cannot be known or done; thus most presumptuously and invidiously turning the weakness of their own discoveries into a calumny on nature herself, and the despair of the rest of the world. Hence the school of the New Academy, which held *Acatalepsia* as a tenet and doomed men to perpetual darkness. Hence the opinion that Forms or true differences of things (which are in fact laws of pure act) are past finding out and beyond the reach of man. Hence too those opinions in the department of action and operation; as that the heat of the sun and of fire are quite different in kind, — lest men should imagine that by the operations of fire anything like the works of nature can be educed and formed. Hence the notion that composition only is the work of man, and mixture of none but nature, — lest men should expect from art some power of generating or transforming natural bodies. By this sign, therefore, men will easily take warning not to mix up their fortunes and labours with dogmas not only despaired of but dedicated to despair.

LXXVI.

Neither is this other sign to be omitted; — that formerly there existed among philosophers such great disagreement, and such diversities in the schools themselves; a fact which sufficiently shows that the road from the senses to the understanding was not skilfully laid out, when the same groundwork of philosophy (the nature of things to wit) was torn and split up into such

vague and multifarious errors. And although in these times disagreements and diversities of opinion on first principles and entire systems are for the most part extinguished, still on parts of philosophy there remain innumerable questions and disputes, so that it plainly appears that neither in the systems themselves nor in the modes of demonstration is there anything certain or sound.

LXXVII.

And as for the general opinion that in the philosophy of Aristotle at any rate there is great agreement; since after its publication the systems of older philosophers died away, while in the times which followed nothing better was found; so that it seems to have been so well laid and established as to have drawn both ages in its train; I answer in the first place, that the common notion of the falling off of the old systems upon the publication of Aristotle's works is a false one; for long afterwards, down even to the times of Cicero and subsequent ages, the works of the old philosophers still remained. But in the times which followed, when on the inundation of barbarians into the Roman empire human learning had suffered shipwreck, then the systems of Aristotle and Plato, like planks of lighter and less solid material, floated on the waves of time, and were preserved. Upon the point of consent also men are deceived, if the matter be looked into more keenly. For true consent is that which consists in the coincidence of free judgments, after due examination. But far the greater number of those who have assented to the philosophy of Aristotle have addicted themselves thereto from prejudgment and upon the authority of others; so that it is a following and going along to-

gether, rather than consent. But even if it had been a real and widespread consent, still so little ought consent to be deemed a sure and solid confirmation, that it is in fact a stronge presumption the other way. For the worst of all auguries is from consent in matters intellectual (divinity excepted, and politics where there is right of vote). For nothing pleases the many unless it strikes the imagination, or binds the understanding with the bands of common notions, as I have already said. We may very well transfer therefore from moral to intellectual matters, the saying of Phocion, that if the multitude assent and applaud men ought immediately to examine themselves as to what blunder or fault they may have committed. This sign therefore is one of the most unfavourable. And so much for this point; namely, that the signs of truth and soundness in the received systems and sciences are not good; whether they be drawn from their origin, or from their fruits, or from their progress, or from the confessions of their founders, or from general consent.

LXXVIII.

I now come to the *causes* of these errors, and of so long a continuance in them through so many ages; which are very many and very potent; — that all wonder how these considerations which I bring forward should have escaped men's notice till now, may cease; and the only wonder be, how now at last they should have entered into any man's head and become the subject of his thoughts; which truly I myself esteem as the result of some happy accident, rather than of any excellence of faculty in me; a birth of Time rather than a birth of Wit. Now, in the first place, those so

many ages, if you weigh the case truly, shrink into a very small compass. For out of the five and twenty centuries over which the memory and learning of men extends, you can hardly pick out six that were fertile in sciences or favourable to their development. In times no less than in regions there are wastes and deserts. For only three revolutions and periods of learning can properly be reckoned; one among the Greeks, the second among the Romans, and the last among us, that is to say, the nations of Western Europe; and to each of these hardly two centuries can justly be assigned. The intervening ages of the world, in respect of any rich or flourishing growth of the sciences, were unprosperous. For neither the Arabians nor the Schoolmen need be mentioned; who in the intermediate times rather crushed[1] the sciences with a multitude of treatises, than increased their weight. And therefore the first cause of so meagre a progress in the sciences is duly and orderly referred to the narrow limits of the time that has been favourable to them.

LXXIX.

In the second place there presents itself a cause of great weight in all ways; namely, that during those very ages in which the wits and learning of men have flourished most, or indeed flourished at all, the least part of their diligence was given to natural philosophy. Yet this very philosophy it is that ought to be esteemed the great mother of the sciences. For all arts and all sciences, if torn from this root, though they may be polished and shaped and made fit for use, yet they will hardly grow. Now it is well known that after the

[1] *Contriverunt:* wore them hard, I suppose; like a path much trodden. —*J. S.*

Christian religion was received and grew strong, by far the greater number of the best wits applied themselves to theology; that to this both the highest rewards were offered, and helps of all kinds most abundantly supplied; and that this devotion to theology chiefly occupied that third portion or epoch of time among us Europeans of the West; and the more so because about the same time both literature began to flourish and religious controversies to spring up. In the age before, on the other hand, during the continuance of the second period among the Romans, the meditations and labours of philosophers were principally employed and consumed on moral philosophy, which to the Heathen was as theology to us. Moreover in those times the greatest wits applied themselves very generally to public affairs; the magnitude of the Roman empire requiring the services of a great number of persons. Again, the age in which natural philosophy was seen to flourish most among the Greeks, was but a brief particle of time; for in early ages the Seven Wise Men, as they were called, (all except Thales) applied themselves to morals and politics; and in later times, when Socrates had drawn down philosophy from heaven to earth, moral philosophy became more fashionable than ever, and diverted the minds of men from the philosophy of nature.

Nay, the very period itself in which inquiries concerning nature flourished, was by controversies and the ambitious display of new opinions corrupted and made useless. Seeing therefore that during those three periods natural philosophy was in a great degree either neglected or hindered, it is no wonder if men made but small advance in that to which they were not attending.

LXXX.

To this it may be added that natural philosophy, even among those who have attended to it, has scarcely ever possessed, especially in these later times, a disengaged and whole man (unless it were some monk studying in his cell, or some gentleman in his country-house), but that it has been made merely a passage and bridge to something else. And so this great mother of the sciences has with strange indignity been degraded to the offices of a servant; having to attend on the business of medicine or mathematics, and likewise to wash and imbue youthful and unripe wits with a sort of first dye, in order that they may be the fitter to receive another afterwards. Meanwhile let no man look for much progress in the sciences — especially in the practical part of them — unless natural philosophy be carried on and applied to particular sciences, and particular sciences be carried back again to natural philosophy. For want of this, astronomy, optics, music, a number of mechanical arts, medicine itself, — nay, what one might more wonder at, moral and political philosophy, and the logical sciences, — altogether lack profoundness, and merely glide along the surface and variety of things; because after these particular sciences have been once distributed and established, they are no more nourished by natural philosophy; which might have drawn out of the true contemplation of motions, rays, sounds, texture and configuration of bodies, affections, and intellectual perceptions, the means of imparting to them fresh strength and growth. And therefore it is nothing strange if the sciences grow not, seeing they are parted from their roots.

LXXXI.

Again there is another great and powerful cause why the sciences have made but little progress; which is this. It is not possible to run a course aright when the goal itself has not been rightly placed. Now the true and lawful goal of the sciences is none other than this: that human life be endowed with new discoveries and powers. But of this the great majority have no feeling, but are merely hireling and professorial; except when it occasionally happens that some workman of acuter wit and covetous of honour applies himself to a new invention; which he mostly does at the expense of his fortunes. But in general, so far are men from proposing to themselves to augment the mass of arts and sciences, that from the mass already at hand they neither take nor look for anything more than what they may turn to use in their lectures, or to gain, or to reputation, or to some similar advantage. And if any one out of all the multitude court science with honest affection and for her own sake, yet even with him the object will be found to be rather the variety of contemplations and doctrines than the severe and rigid search after truth. And if by chance there be one who seeks after truth in earnest, yet even he will propose to himself such a kind of truth as shall yield satisfaction to the mind and understanding in rendering causes for things long since discovered, and not the truth which shall lead to new assurance of works and new light of axioms. If then the end of the sciences has not as yet been well placed, it is not strange that men have erred as to the means.

LXXXII.

And as men have misplaced the end and goal of the sciences; so again, even if they had placed it right, yet they have chosen a way to it which is altogether erroneous and impassable. And an astonishing thing it is to one who rightly considers the matter, that no mortal should have seriously applied himself to the opening and laying out of a road for the human understanding direct from the sense, by a course of experiment orderly conducted and well built up; but that all has been left either to the mist of tradition, or the whirl and eddy of argument, or the fluctuations and mazes of chance and of vague and ill-digested experience. Now let any man soberly and diligently consider what the way is by which men have been accustomed to proceed in the investigation and discovery of things; and in the first place he will no doubt remark a method of discovery very simple and inartificial; which is the most ordinary method, and is no more than this. When a man addresses himself to discover something, he first seeks out and sets before him all that has been said about it by others; then he begins to meditate for himself; and so by much agitation and working of the wit solicits and as it were evokes his own spirit to give him oracles: which method has no foundation at all, but rests only upon opinions and is carried about with them.

Another may perhaps call in logic to discover it for him; but that has no relation to the matter except in name. For logical invention does not discover principles and chief axioms, of which arts are composed, but only such things as appear to be consistent with

them. For if you grow more curious and importunate and busy, and question her of probations and invention of principles or primary axioms, her answer is well known: she refers you to the faith you are bound to give to the principles of each separate art.

There remains simple experience; which, if taken as it comes, is called accident; if sought for, experiment. But this kind of experience is no better than a broom without its band, as the saying is;—a mere groping, as of men in the dark, that feel all round them for the chance of finding their way; when they had much better wait for daylight, or light a candle, and then go. But the true method of experience on the contrary first lights the candle, and then by means of the candle shows the way; commencing as it does with experience duly ordered and digested, not bungling or erratic, and from it educing axioms, and from established axioms again new experiments; even as it was not without order and method that the divine word operated on the created mass. Let men therefore cease to wonder that the course of science is not yet wholly run, seeing that they have gone altogether astray; either leaving and abandoning experience entirely, or losing their way in it and wandering round and round as in a labyrinth; whereas a method rightly ordered leads by an unbroken route through the woods of experience to the open ground of axioms.

LXXXIII.

This evil however has been strangely increased by an opinion or conceit, which though of long standing is vain and hurtful; namely, that the dignity of the human mind is impaired by long and close intercourse

with experiments and particulars, subject to sense and bound in matter; especially as they are laborious to search, ignoble to meditate, harsh to deliver, illiberal to practise, infinite in number, and minute in subtlety. So that it has come at length to this, that the true way is not merely deserted, but shut out and stopped up; experience being, I do not say abandoned or badly managed, but rejected with disdain.

LXXXIV.

Again, men have been kept back as by a kind of enchantment from progress in the sciences by reverence for antiquity, by the authority of men accounted great in philosophy, and then by general consent. Of the last I have spoken above.

As for antiquity, the opinion touching it which men entertain is quite a negligent one, and scarcely consonant with the word itself. For the old age of the world is to be accounted the true antiquity; and this is the attribute of our own times, not of that earlier age of the world in which the ancients lived; and which, though in respect of us it was the elder, yet in respect of the world it was the younger. And truly as we look for greater knowledge of human things and a riper judgment in the old man than in the young, because of his experience and of the number and variety of the things which he has seen and heard and thought of; so in like manner from our age, if it but knew its own strength and chose to essay and exert it, much more might fairly be expected than from the ancient times, inasmuch as it is a more advanced age of the world, and stored and stocked with infinite experiments and observations.

Nor must it go for nothing that by the distant voyages and travels which have become frequent in our times, many things in nature have been laid open and discovered which may let in new light upon philosophy. And surely it would be disgraceful if, while the regions of the material globe, — that is, of the earth, of the sea, and of the stars, — have been in our times laid widely open and revealed, the intellectual globe should remain shut up within the narrow limits of old discoveries.

And with regard to authority, it shows a feeble mind to grant so much to authors and yet deny time his rights, who is the author of authors, nay rather of all authority. For rightly is truth called the daughter of time, not of authority. It is no wonder therefore if those enchantments of antiquity and authority and consent have so bound up men's powers that they have been made impotent (like persons bewitched) to accompany with the nature of things.[1]

LXXXV.

Nor is it only the admiration of antiquity, authority, and consent, that has forced the industry of man to rest satisfied with the discoveries already made; but also an admiration for the works themselves of which the human race has long been in possession. For when a man looks at the variety and the beauty of the provision which the mechanical arts have brought together for men's use, he will certainly be more inclined to admire the wealth of man than to feel his wants: not considering that the original observations and operations of nature (which are the life and moving prin-

[1] Compare *Sylv. Sylvar.* § 888. Vol. v. p. 110. — *J. S.*

ciple of all that variety) are not many nor deeply fetched, and that the rest is but patience, and the subtle and ruled motion of the hand and instruments; — as the making of clocks (for instance) is certainly a subtle and exact work: their wheels seem to imitate the celestial orbs, and their alternating and orderly motion, the pulse of animals: and yet all this depends on one or two axioms of nature.

Again, if you observe the refinement of the liberal arts, or even that which relates to the mechanical preparation of natural substances; and take notice of such things as the discovery in astronomy of the motions of the heavens, of harmony in music, of the letters of the alphabet (to this day not in use among the Chinese) in grammar: or again in things mechanical, the discovery of the works of Bacchus and Ceres — that is, of the arts of preparing wine and beer, and of making bread; the discovery once more of the delicacies of the table, of distillations and the like; and if you likewise bear in mind the long periods which it has taken to bring these things to their present degree of perfection (for they are all ancient except distillation), and again (as has been said of clocks) how little they owe to observations and axioms of nature, and how easily and obviously and as it were by casual suggestion they may have been discovered; you will easily cease from wondering, and on the contrary will pity the condition of mankind, seeing that in a course of so many ages there has been so great a dearth and barrenness of arts and inventions. And yet these very discoveries which we have just mentioned, are older than philosophy and intellectual arts. So that, if the truth must be spoken, when the rational and dogmatical sciences began the discovery of useful works came to an end.

And again, if a man turn from the workshop to the library, and wonder at the immense variety of books he sees there, let him but examine and diligently inspect their matter and contents, and his wonder will assuredly be turned the other way; for after observing their endless repetitions, and how men are ever saying and doing what has been said and done before, he will pass from admiration of the variety to astonishment at the poverty and scantiness of the subjects which till now have occupied and possessed the minds of men.

And if again he descend to the consideration of those arts which are deemed curious rather than safe, and look more closely into the works of the Alchemists or the Magicians, he will be in doubt perhaps whether he ought rather to laugh over them or to weep. For the Alchemist nurses eternal hope, and when the thing fails, lays the blame upon some error of his own; fearing either that he has not sufficiently understood the words of his art or of his authors (whereupon he turns to tradition and auricular whispers), or else that in his manipulations he has made some slip of a scruple in weight or a moment in time (whereupon he repeats his trials to infinity); and when meanwhile among the chances of experiment he lights upon some conclusions either in aspect new or for utility not contemptible, he takes these for earnest of what is to come, and feeds his mind upon them, and magnifies them to the most, and supplies the rest in hope. Not but that Alchemists have made a good many discoveries, and presented men with useful inventions. But their case may be well compared to the fable of the old man, who bequeathed to his sons gold buried in a vineyard, pretending not to know the exact spot; whereupon the sons applied

themselves diligently to the digging of the vineyard, and though no gold was found there, yet the vintage by that digging was made more plentiful.

Again the students of natural magic, who explain everything by Sympathies and Antipathies, have in their idle and most slothful conjectures ascribed to substances wonderful virtues and operations; and if ever they have produced works, they have been such as aim rather at admiration and novelty than at utility and fruit.

In superstitious magic on the other hand (if of this also we must speak), it is especially to be observed that they are but subjects of a certain and definite kind wherein the curious and superstitious arts, in all nations and ages, and religions also, have worked or played. These therefore we may pass. Meanwhile it is nowise strange if opinion of plenty has been the cause of want.

LXXXVI.

Further, this admiration of men for knowledges and arts, — an admiration in itself weak enough, and well-nigh childish, — has been increased by the craft and artifices of those who have handled and transmitted sciences. For they set them forth with such ambition and parade, and bring them into the view of the world so fashioned and masked, as if they were complete in all parts and finished. For if you look at the method of them and the divisions, they seem to embrace and comprise everything which can belong to the subject. And although these divisions are ill filled out and are but as empty cases, still to the common mind they present the form and plan of a perfect science. But the first and most ancient seekers after truth were wont,

with better faith and better fortune too, to throw the knowledge which they gathered from the contemplation of things, and which they meant to store up for use, into aphorisms; that is, into short and scattered sentences, not linked together by an artificial method; and did not pretend or profess to embrace the entire art. But as the matter now is, it is nothing strange if men do not seek to advance in things delivered to them as long since perfect and complete.

LXXXVII.

Moreover the ancient systems have received no slight accession of reputation and credit from the vanity and levity of those who have propounded new ones; especially in the active and practical department of natural philosophy. For there have not been wanting talkers and dreamers who, partly from credulity, partly in imposture, have loaded mankind with promises, offering and announcing the prolongation of life, the retardation of age, the alleviation of pain, the repairing of natural defects, the deceiving of the senses; arts of binding and inciting the affections, of illuminating and exalting the intellectual faculties, of transmuting substances, of strengthening and multiplying motions at will, of making impressions and alterations in the air, of bringing down and procuring celestial influences; arts of divining things future, and bringing things distant near, and revealing things secret; and many more. But with regard to these lavish promisers, this judgment would not be far amiss; that there is as much difference in philosophy between their vanities and true arts, as there is in history between the exploits of Julius Cæsar or Alexander the Great, and the exploits of Amadis of Gaul or Arthur of

Britain. For it is true that those illustrious generals really did greater things than these shadowy heroes are even feigned to have done; but they did them by means and ways of action not fabulous or monstrous. Yet surely it is not fair that the credit of true history should be lessened because it has sometimes been injured and wronged by fables. Meanwhile it is not to be wondered at, if a great prejudice is raised against new propositions, especially when works are also mentioned, because of those impostors who have attempted the like; since their excess of vanity, and the disgust it has bred, have their effect still in the destruction of all greatness of mind in enterprises of this kind.

LXXXVIII.

Far more however has knowledge suffered from littleness of spirit and the smallness and slightness of the tasks which human industry has proposed to itself. And what is worst of all, this very littleness of spirit comes with a certain air of arrogance and superiority.

For in the first place there is found in all arts one general device, which has now become familiar, — that the author lays the weakness of his art to the charge of nature: whatever his art cannot attain he sets down on the authority of the same art to be in nature impossible. And truly no art can be condemned if it be judge itself. Moreover the philosophy which is now in vogue embraces and cherishes certain tenets, the purpose of which (if it be diligently examined) is to persuade men that nothing difficult, nothing by which nature may be commanded and subdued, can be expected from art or human labour; as with respect to the doctrine that the heat of the sun and of fire differ in kind, and to that

other concerning mixture, has been already observed. Which things, if they be noted accurately, tend wholly to the unfair circumscription of human power, and to a deliberate and factitious despair; which not only disturbs the auguries of hope, but also cuts the sinews and spur of industry, and throws away the chances of experience itself; and all for the sake of having their art thought perfect, and for the miserable vain glory of making it believed that whatever has not yet been discovered and comprehended can never be discovered or comprehended hereafter.

And even if a man apply himself fairly to facts, and endeavour to find out something new, yet he will confine his aim and intention to the investigation and working out of some one discovery and no more; such as the nature of the magnet, the ebb and flow of the sea, the system of the heavens, and things of this kind, which seem to be in some measure secret, and have hitherto been handled without much success. Whereas it is most unskilful to investigate the nature of anything in the thing itself; seeing that the same nature which appears in some things to be latent and hidden is in others manifest and palpable; wherefore in the former it produces wonder, in the latter excites no attention; as we find it in the nature of consistency, which in wood or stone is not observed, but is passed over under the appellation of solidity, without further inquiry as to why separation or solution of continuity is avoided; while in the case of bubbles, which form themselves into certain pellicles, curiously shaped into hemispheres, so that the solution of continuity is avoided for a moment, it is thought a subtle matter. In fact what in some things is accounted a secret has in others a mani-

fest and well known nature, which will never be recognised as long as the experiments and thoughts of men are engaged on the former only.

But generally speaking, in mechanics old discoveries pass for new, if a man does but refine or embellish them, or unite several in one, or couple them better with their use, or make the work in greater or less volume than it was before, or the like.

Thus then it is no wonder if noble inventions and worthy of mankind have not been brought to light, when men have been contented and delighted with such trifling and puerile tasks, and have even fancied that in them they have been endeavouring after, if not accomplishing, some great matter.

LXXXIX.

Neither is it to be forgotten that in every age Natural Philosophy has had a troublesome adversary and hard to deal with; namely, superstition, and the blind and immoderate zeal of religion. For we see among the Greeks that those who first proposed to men's then uninitiated ears the natural causes for thunder and for storms, were thereupon found guilty of impiety. Nor was much more forbearance shown by some of the ancient fathers of the Christian church to those who on most convincing grounds (such as no one in his senses would now think of contradicting) maintained that the earth was round, and of consequence asserted the existence of the antipodes.

Moreover, as things now are, to discourse of nature is made harder and more perilous by the summaries and systems of the schoolmen; who having reduced theology into regular order as well as they were able,

and fashioned it into the shape of an art, ended in incorporating the contentious and thorny philosophy of Aristotle, more than was fit, with the body of religion.

To the same result, though in a different way, tend the speculations of those who have taken upon them to deduce the truth of the Christian religion from the principles of philosophers, and to confirm it by their authority; pompously solemnising this union of the sense and faith as a lawful marriage, and entertaining men's minds with a pleasing variety of matter, but all the while disparaging things divine by mingling them with things human. Now in such mixtures of theology with philosophy only the received doctrines of philosophy are included; while new ones, albeit changes for the better, are all but expelled and exterminated.

Lastly, you will find that by the simpleness of certain divines, access to any philosophy, however pure, is well nigh closed. Some are weakly afraid lest a deeper search into nature should transgress the permitted limits of sobermindedness; wrongfully wresting and transferring what is said in holy writ against those who pry into sacred mysteries, to the hidden things of nature, which are barred by no prohibition. Others with more subtlety surmise and reflect that if second causes are unknown everything can more readily be referred to the divine hand and rod; a point in which they think religion greatly concerned; which is in fact nothing else but to seek to gratify God with a lie. Others fear from past example that movements and changes in philosophy will end in assaults on religion. And others again appear apprehensive that in the in-

vestigation of nature something may be found to subvert or at least shake the authority of religion, especially with the unlearned. But these two last fears seem to me to savour utterly of carnal wisdom; as if men in the recesses and secret thoughts of their hearts doubted and distrusted the strength of religion and the empire of faith over the sense, and therefore feared that the investigation of truth in nature might be dangerous to them. But if the matter be truly considered, natural philosophy is after the word of God at once the surest medicine against superstition, and the most approved nourishment for faith, and therefore she is rightly given to religion as her most faithful handmaid, since the one displays the will of God, the other his power. For he did not err who said "Ye err in that ye know not the Scriptures and the power of God," thus coupling and blending in an indissoluble bond information concerning his will and meditation concerning his power. Meanwhile it is not surprising if the growth of Natural Philosophy is checked, when religion, the thing which has most power over men's minds, has by the simpleness and incautious zeal of certain persons been drawn to take part against her.

XC.

Again, in the customs and institutions of schools, academies, colleges, and similar bodies destined for the abode of learned men and the cultivation of learning, everything is found adverse to the progress of science. For the lectures and exercises there are so ordered, that to think or speculate on anything out of the common way can hardly occur to any man. And if one or two have the boldness to use any liberty of judg-

ment, they must undertake the task all by themselves; they can have no advantage from the company of others. And if they can endure this also, they will find their industry and largeness of mind no slight hindrance to their fortune. For the studies of men in these places are confined and as it were imprisoned in the writings of certain authors, from whom if any man dissent he is straightway arraigned as a turbulent person and an innovator. But surely there is a great distinction between matters of state and the arts; for the danger from new motion and from new light is not the same. In matters of state a change even for the better is distrusted, because it unsettles what is established; these things resting on authority, consent, fame and opinion, not on demonstration. But arts and sciences should be like mines, where the noise of new works and further advances is heard on every side. But though the matter be so according to right reason, it is not so acted on in practice; and the points above mentioned in the administration and government of learning put a severe restraint upon the advancement of the sciences.

XCI.

Nay, even if that jealousy were to cease, still it is enough to check the growth of science, that efforts and labours in this field go unrewarded. For it does not rest with the same persons to cultivate sciences and to reward them. The growth of them comes from great wits; the prizes and rewards of them are in the hands of the people, or of great persons, who are but in very few cases even moderately learned. Moreover this kind of progress is not only unrewarded with prizes

and substantial benefits; it has not even the advantage of popular applause. For it is a greater matter than the generality of men can take in, and is apt to be overwhelmed and extinguished by the gales of popular opinions. And it is nothing strange if a thing not held in honour does not prosper.

XCII.

But by far the greatest obstacle to the progress of science and to the undertaking of new tasks and provinces therein, is found in this — that men despair and think things impossible. For wise and serious men are wont in these matters to be altogether distrustful; considering with themselves the obscurity of nature, the shortness of life, the deceitfulness of the senses, the weakness of the judgment, the difficulty of experiment and the like; and so supposing that in the revolution of time and of the ages of the world the sciences have their ebbs and flows; that at one season they grow and flourish, at another wither and decay, yet in such sort that when they have reached a certain point and condition they can advance no further. If therefore any one believes or promises more, they think this comes of an ungoverned and unripened mind, and that such attempts have prosperous beginnings, become difficult as they go on, and end in confusion. Now since these are thoughts which naturally present themselves to grave men and of great judgment, we must take good heed that we be not led away by our love for a most fair and excellent object to relax or diminish the severity of our judgment; we must observe diligently what encouragement dawns upon us and from what quarter; and, putting aside the lighter breezes of hope,

we must thoroughly sift and examine those which promise greater steadiness and constancy. Nay, and we must take state-prudence too into our counsels, whose rule is to distrust, and to take the less favourable view of human affairs. I am now therefore to speak touching Hope; especially as I am not a dealer in promises, and wish neither to force nor to ensnare men's judgments, but to lead them by the hand with their good will. And though the strongest means of inspiring hope will be to bring men to particulars; especially to particulars digested and arranged in my Tables of Discovery (the subject partly of the second, but much more of the fourth part of my Instauration), since this is not merely the promise of the thing but the thing itself; nevertheless that everything may be done with gentleness, I will proceed with my plan of preparing men's minds; of which preparation to give hope is no unimportant part. For without it the rest tends rather to make men sad (by giving them a worse and meaner opinion of things as they are than they now have, and making them more fully to feel and know the unhappiness of their own condition) than to induce any alacrity or to whet their industry in making trial. And therefore it is fit that I publish and set forth those conjectures of mine which make hope in this matter reasonable; just as Columbus did, before that wonderful voyage of his across the Atlantic, when he gave the reasons for his conviction that new lands and continents might be discovered besides those which were known before; which reasons, though rejected at first, were afterwards made good by experience, and were the causes and beginnings of great events.

XCIII.

The beginning is from God: for the business which is in hand, having the character of good so strongly impressed upon it, appears manifestly to proceed from God, who is the author of good, and the Father of Lights. Now in divine operations even the smallest beginnings lead of a certainty to their end. And as it was said of spiritual things, "The kingdom of God cometh not with observation," so is it in all the greater works of Divine Providence; everything glides on smoothly and noiselessly, and the work is fairly going on before men are aware that it has begun. Nor should the prophecy of Daniel be forgotten, touching the last ages of the world:—"Many shall go to and fro, and knowledge shall be increased;" clearly intimating that the thorough passage of the world (which now by so many distant voyages seems to be accomplished, or in course of accomplishment), and the advancement of the sciences, are destined by fate, that is, by Divine Providence, to meet in the same age.

XCIV.

Next comes a consideration of the greatest importance as an argument of hope; I mean that drawn from the errors of past time, and of the ways hitherto trodden. For most excellent was the censure once passed upon a government that had been unwisely administered. "That which is the worst thing in reference to the past, ought to be regarded as best for the future. For if you had done all that your duty demanded, and yet your affairs were no better, you would not have even a hope left you that further improve-

ment is possible. But now, when your misfortunes are owing, not to the force of circumstances, but to your own errors, you may hope that by dismissing or correcting these errors, a great change may be made for the better." In like manner, if during so long a course of years men had kept the true road for discovering and cultivating sciences, and had yet been unable to make further progress therein, bold doubtless and rash would be the opinion that further progress is possible. But if the road itself has been mistaken, and men's labour spent on unfit objects, it follows that the difficulty has its rise not in things themselves, which are not in our power, but in the human understanding, and the use and application thereof, which admits of remedy and medicine. It will be of great use therefore to set forth what these errors are; for as many impediments as there have been in times past from this cause, so many arguments are there of hope for the time to come. And although they have been partly touched before, I think fit here also, in plain and simple words, to represent them.

XCV.

Those who have handled sciences have been either men of experiment or men of dogmas. The men of experiment are like the ant; they only collect and use: the reasoners resemble spiders, who make cobwebs out of their own substance. But the bee takes a middle course; it gathers its material from the flowers of the garden and of the field, but transforms and digests it by a power of its own. Not unlike this is the true business of philosophy; for it neither relies solely or chiefly on the powers of the mind, nor does it take the

matter which it gathers from natural history and mechanical experiments and lay it up in the memory whole, as it finds it; but lays it up in the understanding altered and digested. Therefore from a closer and purer league between these two faculties, the experimental and the rational, (such as has never yet been made) much may be hoped.

XCVI.

We have as yet no natural philosophy that is pure; all is tainted and corrupted; in Aristotle's school by logic; in Plato's by natural theology; in the second school of Platonists, such as Proclus and others, by mathematics, which ought only to give definiteness to natural philosophy, not to generate or give it birth. From a natural philosophy pure and unmixed, better things are to be expected.

XCVII.

No one has yet been found so firm of mind and purpose as resolutely to compel himself to sweep away all theories and common notions, and to apply the understanding, thus made fair and even, to a fresh examination of particulars. Thus it happens that human knowledge, as we have it, is a mere medley and ill-digested mass, made up of much credulity and much accident, and also of the childish notions which we at first imbibed.

Now if any one of ripe age, unimpaired senses, and well-purged mind, apply himself anew to experience and particulars, better hopes may be entertained of that man. In which point I promise to myself a like fortune to that of Alexander the Great; and let no

man tax me with vanity till he have heard the end; for the thing which I mean tends to the putting off of all vanity. For of Alexander and his deeds Æschines spake thus: "Assuredly we do not live the life of mortal men; but to this end were we born, that in after ages wonders might be told of us;" as if what Alexander had done seemed to him miraculous. But in the next age Titus Livius took a better and a deeper view of the matter, saying in effect, that Alexander "had done no more than take courage to despise vain apprehensions." And a like judgment I suppose may be passed on myself in future ages: that I did no great things, but simply made less account of things that were accounted great. In the meanwhile, as I have already said, there is no hope except in a new birth of science; that is, in raising it regularly up from experience and building it afresh; which no one (I think) will say has yet been done or thought of.

XCVIII.

Now for grounds of experience — since to experience we must come — we have as yet had either none or very weak ones; no search has been made to collect a store of particular observations sufficient either in number, or in kind, or in certainty, to inform the understanding, or in any way adequate. On the contrary, men of learning, but easy withal and idle, have taken for the construction or for the confirmation of their philosophy certain rumours and vague fames or airs of experience, and allowed to these the weight of lawful evidence. And just as if some kingdom or state were to direct its counsels and affairs, not by letters and reports from ambassadors and trustworthy messengers,

but by the gossip of the streets; such exactly is the system of management introduced into philosophy with relation to experience. Nothing duly investigated, nothing verified, nothing counted, weighed, or measured, is to be found in natural history: and what in observation is loose and vague, is in information deceptive and treacherous. And if any one thinks that this is a strange thing to say, and something like an unjust complaint, seeing that Aristotle, himself so great a man, and supported by the wealth of so great a king, has composed so accurate a history of animals; and that others with greater diligence, though less pretence, have made many additions; while others, again, have compiled copious histories and descriptions of metals, plants, and fossils; it seems that he does not rightly apprehend what it is that we are now about. For a natural history which is composed for its own sake is not like one that is collected to supply the understanding with information for the building up of philosophy. They differ in many ways, but especially in this; that the former contains the variety of natural species only, and not experiments of the mechanical arts. For even as in the business of life a man's disposition and the secret workings of his mind and affections are better discovered when he is in trouble than at other times; so likewise the secrets of nature reveal themselves more readily under the vexations of art than when they go their own way. Good hopes may therefore be conceived of natural philosophy, when natural history, which is the basis and foundation of it, has been drawn up on a better plan; but not till then.

XCIX.

Again, even in the great plenty of mechanical experiments, there is yet a great scarcity of those which are of most use for the information of the understanding. For the mechanic, not troubling himself with the investigation of truth, confines his attention to those things which bear upon his particular work, and will not either raise his mind or stretch out his hand for anything else. But then only will there be good ground of hope for the further advance of knowledge, when there shall be received and gathered together into natural history a variety of experiments, which are of no use in themselves, but simply serve to discover causes and axioms; which I call "*Experimenta lucifera*," experiments of *light*, to distinguish them from those which I call "*fructifera*," experiments of *fruit*.

Now experiments of this kind have one admirable property and condition; they never miss or fail. For since they are applied, not for the purpose of producing any particular effect, but only of discovering the natural cause of some effect, they answer the end equally well whichever way they turn out; for they settle the question.

C.

But not only is a greater abundance of experiments to be sought for and procured, and that too of a different kind from those hitherto tried; an entirely different method, order, and process for carrying on and advancing experience must also be introduced. For experience, when it wanders in its own track, is, as I have already remarked, mere groping in the dark, and

confounds men rather than instructs them. But when it shall proceed in accordance with a fixed law, in regular order, and without interruption, then may better things be hoped of knowledge.

CI.

But even after such a store of natural history and experience as is required for the work of the understanding, or of philosophy, shall be ready at hand, still the understanding is by no means competent to deal with it off hand and by memory alone; no more than if a man should hope by force of memory to retain and make himself master of the computation of an ephemeris. And yet hitherto more has been done in matter of invention by thinking than by writing; and experience has not yet learned her letters. Now no course of invention can be satisfactory unless it be carried on in writing. But when this is brought into use, and experience has been taught to read and write, better things may be hoped.

CII.

Moreover, since there is so great a number and army of particulars, and that army so scattered and dispersed as to distract and confound the understanding, little is to be hoped for from the skirmishings and slight attacks and desultory movements of the intellect, unless all the particulars which pertain to the subject of inquiry shall, by means of Tables of Discovery, apt, well arranged, and as it were animate, be drawn up and marshalled; and the mind be set to work upon the helps duly prepared and digested which these tables supply.

CIII.

But after this store of particulars has been set out duly and in order before our eyes, we are not to pass at once to the investigation and discovery of new particulars or works; or at any rate if we do so we must not stop there. For although I do not deny that when all the experiments of all the arts shall have been collected and digested, and brought within one man's knowledge and judgment, the mere transferring of the experiments of one art to others may lead, by means of that experience which I term *literate*, to the discovery of many new things of service to the life and state of man, yet it is no great matter that can be hoped from that; but from the new light of axioms, which having been educed from those particulars by a certain method and rule, shall in their turn point out the way again to new particulars, greater things may be looked for. For our road does not lie on a level, but ascends and descends; first ascending to axioms, then descending to works.

CIV.

The understanding must not however be allowed to jump and fly from particulars to remote axioms and of almost the highest generality (such as the first principles, as they are called, of arts and things), and taking stand upon them as truths that cannot be shaken, proceed to prove and frame the middle axioms by reference to them; which has been the practice hitherto; the understanding being not only carried that way by a natural impulse, but also by the use of syllogistic demonstration trained and inured to it. But then, and then only, may we hope well of the sciences,

when in a just scale of ascent, and by successive steps not interrupted or broken, we rise from particulars to lesser axioms; and then to middle axioms, one above the other; and last of all to the most general. For the lowest axioms differ but slightly from bare experience, while the highest and most general (which we now have) are notional and abstract and without solidity. But the middle are the true and solid and living axioms, on which depend the affairs and fortunes of men; and above them again, last of all, those which are indeed the most general; such I mean as are not abstract, but of which those intermediate axioms are really limitations.

The understanding must not therefore be supplied with wings, but rather hung with weights, to keep it from leaping and flying. Now this has never yet been done; when it is done, we may entertain better hopes of the sciences.

CV.

In establishing axioms, another form of induction must be devised than has hitherto been employed; and it must be used for proving and discovering not first principles (as they are called) only, but also the lesser axioms, and the middle, and indeed all. For the induction which proceeds by simple enumeration is childish; its conclusions are precarious, and exposed to peril from a contradictory instance; and it generally decides on too small a number of facts, and on those only which are at hand. But the induction which is to be available for the discovery and demonstration of sciences and arts, must analyse nature by proper rejections and exclusions; and then, after a sufficient number of negatives, come to a conclusion on the affirm-

ative instances: which has not yet been done or even attempted, save only by Plato, who does indeed employ this form of induction to a certain extent for the purpose of discussing definitions and ideas. But in order to furnish this induction or demonstration well and duly for its work, very many things are to be provided which no mortal has yet thought of; insomuch that greater labour will have to be spent in it than has hitherto been spent on the syllogism. And this induction must be used not only to discover axioms, but also in the formation of notions. And it is in this induction that our chief hope lies.

CVI.

But in establishing axioms by this kind of induction, we must also examine and try whether the axiom so established be framed to the measure of those particulars only from which it is derived, or whether it be larger and wider. And if it be larger and wider, we must observe whether by indicating to us new particulars it confirm that wideness and largeness as by a collateral security; that we may not either stick fast in things already known, or loosely grasp at shadows and abstract forms; not at things solid and realised in matter. And when this process shall have come into use, then at last shall we see the dawn of a solid hope.

CVII.

And here also should be remembered what was said above concerning the extending of the range of natural philosophy to take in the particular sciences, and the referring or bringing back of the particular sciences to natural philosophy; that the branches of knowledge

may not be severed and cut off from the stem. For without this the hope of progress will not be so good.

CVIII.

So much then for the removing of despair and the raising of hope through the dismissal or rectification of the errors of past time. We must now see what else there is to ground hope upon. And this consideration occurs at once — that if many useful discoveries have been made by accident or upon occasion, when men were not seeking for them but were busy about other things; no one can doubt but that when they apply themselves to seek and make this their business, and that too by method and in order and not by desultory impulses, they will discover far more. For although it may happen once or twice that a man shall stumble on a thing by accident which, when taking great pains to search for it, he could not find; yet upon the whole it unquestionably falls out the other way. And therefore far better things, and more of them, and at shorter intervals, are to be expected from man's reason and industry and direction and fixed application, than from accident and animal instinct and the like, in which inventions have hitherto had their origin.

CIX.

Another argument of hope may be drawn from this, — that some of the inventions already known are such as before they were discovered it could hardly have entered any man's head to think of; they would have been simply set aside as impossible. For in conjecturing what may be men set before them the example of what has been, and divine of the new with an imagina-

tion preoccupied and coloured by the old; which way of forming opinions is very fallacious; for streams that are drawn from the springheads of nature do not always run in the old channels.

If, for instance, before the invention of ordnance, a man had described the thing by its effects, and said that there was a new invention, by means of which the strongest towers and walls could be shaken and thrown down at a great distance; men would doubtless have begun to think over all the ways of multiplying the force of catapults and mechanical engines by weights and wheels and such machinery for ramming and projecting; but the notion of a fiery blast suddenly and violently expanding and exploding would hardly have entered into any man's imagination or fancy; being a thing to which nothing immediately analogous had been seen, except perhaps in an earthquake or in lightning, which as *magnalia* or marvels of nature, and by man not imitable, would have been immediately rejected.

In the same way, if before the discovery of silk, any one had said that there was a kind of thread discovered for the purposes of dress and furniture, which far surpassed the thread of linen or of wool in fineness and at the same time in strength, and also in beauty and softness; men would have begun immediately to think of some silky kind of vegetable, or of the finer hair of some animal, or of the feathers and down of birds; but of a web woven by a tiny worm, and that in such abundance, and renewing itself yearly, they would assuredly never have thought. Nay, if any one had said anything about a worm, he would no doubt have been laughed at as dreaming of a new kind of cobwebs.

So again, if before the discovery of the magnet, any

one had said that a certain instrument had been invented by means of which the quarters and points of the heavens could be taken and distinguished with exactness; men would have been carried by their imagination to a variety of conjectures concerning the more exquisite construction of astronomical instruments; but that anything could be discovered agreeing so well in its movements with the heavenly bodies, and yet not a heavenly body itself, but simply a substance of metal or stone, would have been judged altogether incredible. Yet these things and others like them lay for so many ages of the world concealed from men, nor was it by philosophy or the rational arts that they were found out at last, but by accident and occasion; being indeed, as I said, altogether different in kind and as remote as possible from anything that was known before; so that no preconceived notion could possibly have led to the discovery of them.

There is therefore much ground for hoping that there are still laid up in the womb of nature many secrets of excellent use, having no affinity or parallelism with any thing that is now known, but lying entirely out of the beat of the imagination, which have not yet been found out. They too no doubt will some time or other, in the course and revolution of many ages, come to light of themselves, just as the others did; only by the method of which we are now treating they can be speedily and suddenly and simultaneously presented and anticipated.

CX.

But we have also discoveries to show of another kind, which prove that noble inventions may be lying at our

very feet, and yet mankind may step over without seeing them. For however the discovery of gunpowder, of silk, of the magnet, of sugar, of paper, or the like, may seem to depend on certain properties of things themselves and nature, there is at any rate nothing in the art of printing which is not plain and obvious. Nevertheless for want of observing that although it is more difficult to arrange types of letters than to write letters by the motion of the hand, there is yet this difference between the two, that types once arranged serve for innumerable impressions, but letters written with the hand for a single copy only; or perhaps again for want of observing that ink can be so thickened as to colour without running (particularly when the letters face upwards and the impression is made from above) — for want, I say, of observing these things, men went for so many ages without this most beautiful discovery, which is of so much service in the propagation of knowledge.

But such is the infelicity and unhappy disposition of the human mind in this course of invention, that it first distrusts and then despises itself: first will not believe that any such thing can be found out; and when it is found out, cannot understand how the world should have missed it so long. And this very thing may be justly taken as an argument of hope; namely, that there is a great mass of inventions still remaining, which not only by means of operations that are yet to be discovered, but also through the transferring, comparing, and applying of those already known, by the help of that Learned Experience of which I spoke, may be deduced and brought to light.

CXI.

There is another ground of hope that must not be omitted. Let men but think over their infinite expenditure of understanding, time, and means on matters and pursuits of far less use and value; whereof if but a small part were directed to sound and solid studies, there is no difficulty that might not be overcome. This I thought good to add, because I plainly confess that a collection of history natural and experimental, such as I conceive it and as it ought to be, is a great, I may say a royal work, and of much labour and expense.

CXII.

Meantime, let no man be alarmed at the multitude of particulars, but let this rather encourage him to hope. For the particular phenomena of art and nature are but a handful to the inventions of the wit, when disjoined and separated from the evidence of things. Moreover this road has an issue in the open ground and not far off; the other has no issue at all, but endless entanglement. For men hitherto have made but short stay with experience, but passing her lightly by, have wasted an infinity of time on meditations and glosses of the wit. But if some one were by that could answer our questions and tell us in each case what the fact in nature is, the discovery of all causes and sciences would be but the work of a few years.

CXIII.

Moreover I think that men may take some hope from my own example. And this I say not by way of boasting, but because it is useful to say it. If there be any

that despond, let them look at me, that being of all men of my time the most busied in affairs of state, and a man of health not very strong (whereby much time is lost), and in this course altogether a pioneer, following in no man's track, nor sharing these counsels with any one, have nevertheless by resolutely entering on the true road, and submitting my mind to Things, advanced these matters, as I suppose, some little way. And then let them consider what may be expected (after the way has been thus indicated) from men abounding in leisure, and from association of labours, and from successions of ages: the rather because it is not a way over which only one man can pass at a time (as is the case with that of reasoning), but one in which the labours and industries of men (especially as regards the collecting of experience) may with the best effect be first distributed and then combined. For then only will men begin to know their strength, when instead of great numbers doing all the same things, one shall take charge of one thing and another of another.

CXIV.

Lastly, even if the breath of hope which blows on us from that New Continent were fainter than it is and harder to perceive; yet the trial (if we would not bear a spirit altogether abject) must by all means be made. For there is no comparison between that which we may lose by not trying and by not succeeding; since by not trying we throw away the chance of an immense good; by not succeeding we only incur the loss of a little human labour. But as it is, it appears to me from what has been said, and also from what has been left unsaid, that there is hope enough and to spare, not only to

make a bold man try, but also to make a sober-minded and wise man believe.

CXV.

Concerning the grounds then for putting away despair, which has been one of the most powerful causes of delay and hindrance to the progress of knowledge, I have now spoken. And this also concludes what I had to say touching the *signs* and *causes* of the errors, sluggishness, and ignorance which have prevailed; especially since the more subtle causes, which do not fall under popular judgment and observation, must be referred to what has been said on the Idols of the human mind.

And here likewise should close that part of my Instauration, which is devoted to pulling down: which part is performed by three refutations; first, by the refutation of the *natural human reason*, left to itself; secondly, by the refutation of the *demonstrations;* and thirdly, by the refutation of the *theories*, or the received systems of philosophy and doctrine. And the refutation of these has been such, as alone it could be: that is to say, by signs and the evidence of causes; since no other kind of confutation was open to me, differing as I do from others both on first principles and on rules of demonstration.

It is time therefore to proceed to the art itself and rule of interpreting nature; still however there remains something to be premised. For whereas in this first book of aphorisms I proposed to prepare men's minds as well for understanding as for receiving what is to follow; now that I have purged and swept and levelled the floor of the mind, it remains that I place the mind in a good position and as it were in a favour-

able aspect towards what I have to lay before it. For in a new matter, it is not only the strong preoccupation of some old opinion that tends to create a prejudice, but also a false preconception or prefiguration of the new thing which is presented. I will endeavour therefore to impart sound and true opinions as to the things I propose, although they are to serve only for the time, and by way of interest (so to speak), till the thing itself, which is the principal, be fully known.

CXVI.

First, then, I must request men not to suppose that after the fashion of ancient Greeks, and of certain moderns, as Telesius, Patricius, Severinus, I wish to found a new sect in philosophy. For this is not what I am about; nor do I think that it matters much to the fortunes of men what abstract notions one may entertain concerning nature and the principles of things; and no doubt many old theories of this kind can be revived and many new ones introduced; just as many theories of the heavens may be supposed, which agree well enough with the phenomena and yet differ with each other.

But for my part I do not trouble myself with any such speculative and withal unprofitable matters. My purpose, on the contrary, is to try whether I cannot in very fact lay more firmly the foundations, and extend more widely the limits, of the power and greatness of man. And although on some special subjects and in an incomplete form I am in possession of results which I take to be far more true and more certain and withal more fruitful than those now received, (and these I have collected into the fifth part of my Instauration,)

yet I have no entire or universal theory to propound. For it does not seem that the time is come for such an attempt. Neither can I hope to live to complete the sixth part of the Instauration (which is destined for the philosophy discovered by the legitimate interpretation of nature), but hold it enough if in the intermediate business I bear myself soberly and profitably, sowing in the meantime for future ages the seeds of a purer truth, and performing my part towards the commencement of the great undertaking.

CXVII.

And as I do not seek to found a school, so neither do I hold out offers or promises of particular works. It may be thought indeed, that I who make such frequent mention of works and refer everything to that end, should produce some myself by way of earnest. But my course and method, as I have often clearly stated and would wish to state again, is this, — not to extract works from works or experiments from experiments (as an empiric), but from works and experiments to extract causes and axioms, and again from those causes and axioms new works and experiments, as a legitimate interpreter of nature. And although in my tables of discovery (which compose the fourth part of the Instauration), and also in the examples of particulars (which I have adduced in the second part), and moreover in my observations on the history (which I have drawn out in the third part), any reader of even moderate sagacity and intelligence will everywhere observe indications and outlines of many noble works; still I candidly confess that the natural history which I now have, whether collected from books or from my

own investigations, is neither sufficiently copious nor verified with sufficient accuracy to serve the purposes of legitimate interpretation.

Accordingly, if there be any one more apt and better prepared for mechanical pursuits, and sagacious in hunting out works by the mere dealing with experiment, let him by all means use his industry to gather from my history and tables many things by the way, and apply them to the production of works, which may serve as interest until the principal be forthcoming. But for myself, aiming as I do at greater things, I condemn all unseasonable and premature tarrying over such things as these; being (as I often say) like Atalanta's balls. For I do not run off like a child after golden apples, but stake all on the victory of art over nature in the race; nor do I make haste to mow down the moss or the corn in blade, but wait for the harvest in its due season.

CXVIII.

There will be found no doubt, when my history and tables of discovery are read, some things in the experiments themselves that are not quite certain, or perhaps that are quite false; which may make a man think that the foundations and principles upon which my discoveries rest are false and doubtful. But this is of no consequence; for such things must needs happen at first. It is only like the occurrence in a written or printed page of a letter or two mistaken or misplaced; which does not much hinder the reader, because such errors are easily corrected by the sense. So likewise may there occur in my natural history many experiments which are mistaken and falsely set down, and yet they will presently by the discovery of causes and axioms

be easily expunged and rejected. It is nevertheless true that if the mistakes in natural history and experiments are important, frequent, and continual, they cannot possibly be corrected or amended by any felicity of wit or art. And therefore, if in my natural history, which has been collected and tested with so much diligence, severity, and I may say religious care, there still lurk at intervals certain falsities or errors in the particulars, — what is to be said of common natural history, which in comparison with mine is so negligent and inexact? and what of the philosophy and sciences built on such a sand (or rather quicksand)? Let no man therefore trouble himself for this.

CXIX.

There will be met with also in my history and experiments many things which are trivial and commonly known; many which are mean and low; many, lastly, which are too subtle and merely speculative, and that seem to be of no use; which kind of things may possibly avert and alienate men's interest.

And first for those things which seem common; let men bear in mind that hitherto they have been accustomed to do no more than refer and adapt the causes of things which rarely happen to such as happen frequently; while of those which happen frequently they never ask the cause, but take them as they are for granted. And therefore they do not investigate the causes of weight, of the rotation of heavenly bodies, of heat, cold, light, hardness, softness, rarity, density, liquidity, solidity, animation, inanimation, similarity, dissimilarity, organisation, and the like; but admitting these as self-evident and obvious, they dispute and de-

cide on other things of less frequent and familiar occurrence.

But I, who am well aware that no judgment can be passed on uncommon or remarkable things, much less anything new brought to light, unless the causes of common things, and the causes of those causes, be first duly examined and found out, am of necessity compelled to admit the commonest things into my history. Nay, in my judgment philosophy has been hindered by nothing more than this, — that things of familiar and frequent occurrence do not arrest and detain the thoughts of men, but are received in passing without any inquiry into their causes; insomuch that information concerning things which are not known is not oftener wanted than attention concerning things which are.

CXX.

And for things that are mean or even filthy, — things which (as Pliny says) must be introduced with an apology, — such things, no less than the most splendid and costly, must be admitted into natural history. Nor is natural history polluted thereby; for the sun enters the sewer no less than the palace, yet takes no pollution. And for myself, I am not raising a capitol or pyramid to the pride of man, but laying a foundation in the human understanding for a holy temple after the model of the world. That model therefore I follow. For whatever deserves to exist deserves also to be known, for knowledge is the image of existence; and things mean and splendid exist alike. Moreover as from certain putrid substances — musk, for instance, and civet — the sweetest odours are sometimes generated, so too from mean and sordid instances there

sometimes emanates excellent light and information. But enough and more than enough of this; such fastidiousness being merely childish and effeminate.

CXXI.

But there is another objection which must be more carefully looked to: namely, that there are many things in this History which to common apprehension, or indeed to any understanding accustomed to the present system, will seem to be curiously and unprofitably subtle. Upon this point therefore above all I must say again what I have said already, — that at first and for a time I am seeking for experiments of light, not for experiments of fruit; following therein, as I have often said, the example of the divine creation; which on the first day produced light only, and assigned to it alone one entire day, nor mixed up with it on that day any material work.

To suppose therefore that things like these are of no use is the same as to suppose that light is of no use, because it is not a thing solid or material. And the truth is that the knowledge of simple natures well examined and defined is as light; it gives entrance to all the secrets of nature's workshop, and virtually includes and draws after it whole bands and troops of works, and opens to us the sources of the noblest axioms; and yet in itself it is of no great use. So also the letters of the alphabet in themselves and apart have no use or meaning, yet they are the subject-matter for the composition and apparatus of all discourse. So again the seeds of things are of much latent virtue, and yet of no use except in their development. And the scattered rays of light itself, until they are made to converge, can impart none of their benefit.

But if objection be taken to speculative subtleties, what is to be said of the schoolmen, who have indulged in subtleties to such excess? in subtleties too that were spent on words, or at any rate on popular notions (which is much the same thing), not on facts or nature; and such as were useless not only in their origin but also in their consequences; and not like those I speak of, useless indeed for the present, but promising infinite utility hereafter. But let men be assured of this, that all subtlety of disputation and discourse, if not applied till after axioms are discovered, is out of season and preposterous; and that the true and proper or at any rate the chief time for subtlety is in weighing experience and in founding axioms thereon; for that other subtlety, though it grasps and snatches at nature, yet can never take hold of her. Certainly what is said of opportunity or fortune is most true of nature; she has a lock in front, but is bald behind.

Lastly, concerning the disdain to receive into natural history things either common, or mean, or over-subtle and in their original condition useless, the answer of the poor woman to the haughty prince, who had rejected her petition as an unworthy thing and beneath his dignity, may be taken for an oracle, — "Then leave off being king." For most certain it is that he who will not attend to things like these, as being too paltry and minute, can neither win the kingdom of nature nor govern it.

CXXII.

It may be thought also a strange and a harsh thing that we should at once and with one blow set aside all sciences and all authors; and that too without calling

in any of the ancients to our aid and support, but relying on our own strength.

And I know that if I had chosen to deal less sincerely, I might easily have found authority for my suggestions by referring them either to the old times before the Greeks (when natural science was perhaps more flourishing, though it made less noise, not having yet passed into the pipes and trumpets of the Greeks), or even, in part at least, to some of the Greeks themselves; and so gained for them both support and honour; as men of no family devise for themselves by the good help of genealogies the nobility of a descent from some ancient stock. But for my part, relying on the evidence and truth of things, I reject all forms of fiction and imposture; nor do I think that it matters any more to the business in hand, whether the discoveries that shall now be made were long ago known to the ancients, and have their settings and their risings according to the vicissitude of things and course of ages, than it matters to mankind whether the new world be that island of Atlantis with which the ancients were acquainted, or now discovered for the first time. For new discoveries must be sought from the light of nature, not fetched back out of the darkness of antiquity.

And as for the universality of the censure, certainly if the matter be truly considered, such a censure is not only more probable but more modest too, than a partial one would be. For if the errors had not been rooted in primary notions, there must have been some true discoveries to correct the false. But the errors being fundamental, and not so much of false judgment as of inattention and oversight, it is no wonder that men

have not obtained what they have not tried for, nor reached a mark which they never set up, nor finished a course which they never entered on or kept.

And as for the presumption implied in it; certainly if a man undertakes by steadiness of hand and power of eye to describe a straighter line or more perfect circle than any one else, he challenges a comparison of abilities; but if he only says that he with the help of a rule or a pair of compasses can draw a straighter line or a more perfect circle than any one else can by eye and hand alone, he makes no great boast. And this remark, be it observed, applies not merely to this first and inceptive attempt of mine, but to all that shall take the work in hand hereafter. For my way of discovering sciences goes far to level men's wits, and leave but little to individual excellence; because it performs everything by the surest rules and demonstrations. And therefore I attribute my part in all this, as I have often said, rather to good luck than to ability, and account it a birth of time rather than of wit. For certainly chance has something to do with men's thoughts, as well as with their works and deeds.

CXXIII.

I may say then of myself that which one said in jest (since it marks the distinction so truly), "It cannot be that we should think alike, when one drinks water and the other drinks wine." Now other men, as well in ancient as in modern times, have in the matter of sciences drunk a crude liquor like water, either flowing spontaneously from the understanding, or drawn up by logic, as by wheels from a well. Whereas I pledge mankind in a liquor strained from countless grapes,

from grapes ripe and fully seasoned, collected in clusters, and gathered and then squeezed in the press, and finally purified and clarified in the vat. And therefore it is no wonder if they and I do not think alike.

CXXIV.

Again, it will be thought, no doubt, that the goal and mark of knowledge which I myself set up (the very point which I object to in others) is not the true or the best; for that the contemplation of truth is a thing worthier and loftier than all utility and magnitude of works; and that this long and anxious dwelling with experience and matter and the fluctuations of individual things, drags down the mind to earth, or rather sinks it to a very Tartarus of turmoil and confusion; removing and withdrawing it from the serene tranquillity of abstract wisdom, a condition far more heavenly. Now to this I readily assent; and indeed this which they point at as so much to be preferred, is the very thing of all others which I am about. For I am building in the human understanding a true model of the world, such as it is in fact, not such as a man's own reason would have it to be; a thing which cannot be done without a very diligent dissection and anatomy of the world. But I say that those foolish and apish images of worlds which the fancies of men have created in philosophical systems, must be utterly scattered to the winds. Be it known then how vast a difference there is (as I said above) between the Idols of the human mind and the Ideas of the divine. The former are nothing more than arbitrary abstractions; the latter are the Creator's own stamp upon creation, impressed and defined in matter by true and exquisite lines.

Truth therefore and utility are here the very same things:[1] and works themselves are of greater value as pledges of truth than as contributing to the comforts of life.

CXXV.

It may be thought again that I am but doing what has been done before; that the ancients themselves took the same course which I am now taking; and that it is likely therefore that I too, after all this stir and striving, shall come at last to some one of those systems which prevailed in ancient times. For the ancients too, it will be said, provided at the outset of their speculations a great store and abundance of examples and particulars, digested the same into note-books under heads and titles, from them completed their systems and arts, and afterwards, when they understood the matter, published them to the world,— adding a few examples here and there for proof and illustration; but thought it superfluous and inconvenient to publish their notes and minutes and digests of particulars; and therefore did as builders do,— after the house was built they removed the scaffolding and ladders out of sight. And so no doubt they did. But this objection (or scruple rather) will be easily answered by any one who has not quite forgotten what I have said above. For the form of inquiry and discovery that was in use among the ancients is by themselves professed, and appears on the very face of their writings. And that form was simply this. From a few examples and particulars (with the addition of common notions and perhaps of some portion of the

[1] *Ipsissimæ res.* I think this must have been Bacon's meaning, though not a meaning which the word can properly bear. — *J. S.*

received opinions which have been most popular) they flew at once to the most general conclusions, or first principles of science: taking the truth of these as fixed and immoveable, they proceeded by means of intermediate propositions to educe and prove from them the inferior conclusions; and out of these they framed the art. After that, if any new particulars and examples repugnant to their dogmas were mooted and adduced, either they subtly moulded them into their system by distinctions or explanations of their rules, or else coarsely got rid of them by exceptions; while to such particulars as were not repugnant they laboured to assign causes in conformity with those their principles. But this was not the natural history and experience that was wanted; far from it; and besides, that flying off to the highest generalities ruined all.

CXXVI.

It will also be thought that by forbidding men to pronounce and to set down principles as established until they have duly arrived through the intermediate steps at the highest generalities, I maintain a sort of suspension of the judgment, and bring it to what the Greeks call *Acatalepsia*, — a denial of the capacity of the mind to comprehend truth. But in reality that which I meditate and propound is not *Acatalepsia*, but *Eucatalepsia;* not denial of the capacity to understand, but provision for understanding truly; for I do not take away authority from the senses, but supply them with helps; I do not slight the understanding, but govern it. And better surely it is that we should know all we need to know, and yet think our knowledge imperfect, than that we should think our knowl-

edge perfect, and yet not know anything we need to know.

CXXVII.

It may also be asked (in the way of doubt rather than objection) whether I speak of natural philosophy only, or whether I mean that the other sciences, logic, ethics, and politics, should be carried on by this method. Now I certainly mean what I have said to be understood of them all; and as the common logic, which governs by the syllogism, extends not only to natural but to all sciences; so does mine also, which proceeds by induction, embrace everything. For I form a history and tables of discovery for anger, fear, shame, and the like; for matters political; and again for the mental operations of memory, composition and division, judgment and the rest; not less than for heat and cold, or light, or vegetation, or the like. But nevertheless since my method of interpretation, after the history has been prepared and duly arranged, regards not the working and discourse of the mind only (as the common logic does) but the nature of things also, I supply the mind with such rules and guidance that it may in every case apply itself aptly to the nature of things. And therefore I deliver many and diverse precepts in the doctrine of Interpretation, which in some measure modify the method of invention according to the quality and condition of the subject of the inquiry.

CXXVIII.

On one point not even a doubt ought to be entertained; namely, whether I desire to pull down and destroy the philosophy and arts and sciences which are at present in use. So far from that, I am most

glad to see them used, cultivated, and honoured. There is no reason why the arts which are now in fashion should not continue to supply matter for disputation and ornaments for discourse, to be employed for the conveniënce of professors and men of business; to be in short like current coin, which passes among men by consent. Nay I frankly declare that what I am introducing will be but little fitted for such purposes as these, since it cannot be brought down to common apprehension, save by effects and works only. But how sincere I am in my professions of affection and good will towards the received sciences, my published writings, especially the books on the Advancement of Learning, sufficiently show; and therefore I will not attempt to prove it further by words. Meanwhile I give constant and distinct warning that by the methods now in use neither can any great progress be made in the doctrines and contemplative part of sciences, nor can they be carried out to any magnitude of works.

CXXIX.

It remains for me to say a few words touching the excellency of the end in view. Had they been uttered earlier, they might have seemed like idle wishes; but now that hopes have been raised and unfair prejudices removed, they may perhaps have greater weight. Also if I had finished all myself, and had no occasion to call in others to help and take part in the work, I should even now have abstained from such language, lest it might be taken as a proclamation of my own deserts. But since I want to quicken the industry and rouse and kindle the zeal of others, it is fitting that I put men in mind of some things.

In the first place then, the introduction of famous discoveries appears to hold by far the first place among human actions; and this was the judgment of the former ages. For to the authors of inventions they awarded divine honours; while to those who did good service in the state (such as founders of cities and empires, legislators, saviours of their country from long endured evils, quellers of tyrannies, and the like) they decreed no higher honours than heroic. And certainly if a man rightly compare the two, he will find that this judgment of antiquity was just. For the benefits of discoveries may extend to the whole race of man, civil benefits only to particular places; the latter last not beyond a few ages, the former through all time. Moreover the reformation of a state in civil matters is seldom brought in without violence and confusion; but discoveries carry blessings with them, and confer benefits without causing harm or sorrow to any.

Again, discoveries are as it were new creations, and imitations of God's works; as well sang the poet: —

> "To man's frail race great Athens long ago
> First gave the seed whence waving harvests grow,
> And *re-created* all our life below."

And it appears worthy of remark in Solomon, that though mighty in empire and in gold; in the magnificence of his works, his court, his household, and his fleet; in the lustre of his name and the worship of mankind; yet he took none of these to glory in, but pronounced that "The glory of God is to conceal a thing; the glory of the king to search it out."

Again, let a man only consider what a difference there is between the life of men in the most civilised

province of Europe, and in the wildest and most barbarous districts of New India; he will feel it be great enough to justify the saying that "man is a god to man," not only in regard of aid and benefit, but also by a comparison of condition. And this difference comes not from soil, not from climate, not from race, but from the arts.

Again, it is well to observe the force and virtue and consequences of discoveries; and these are to be seen nowhere more conspicuously than in those three which were unknown to the ancients, and of which the origin, though recent, is obscure and inglorious; namely, printing, gunpowder, and the magnet. For these three have changed the whole face and state of things throughout the world; the first in literature, the second in warfare, the third in navigation; whence have followed innumerable changes; insomuch that no empire, no sect, no star seems to have exerted greater power and influence in human affairs than these mechanical discoveries.

Further, it will not be amiss to distinguish the three kinds and as it were grades of ambition in mankind. The first is of those who desire to extend their own power in their native country; which kind is vulgar and degenerate. The second is of those who labour to extend the power of their country and its dominion among men. This certainly has more dignity, though not less covetousness. But if a man endeavour to establish and extend the power and dominion of the human race itself over the universe, his ambition (if ambition it can be called) is without doubt both a more wholesome thing and a more noble than the other two. Now the empire of man over things depends wholly

on the arts and sciences. For we cannot command nature except by obeying her.

Again, if men have thought so much of some one particular discovery as to regard him as more than man who has been able by some benefit to make the whole human race his debtor, how much higher a thing to discover that by means of which all things else shall be discovered with ease! And yet (to speak the whole truth), as the uses of light are infinite, in enabling us to walk, to ply our arts, to read, to recognise one another; and nevertheless the very beholding of the light is itself a more excellent and a fairer thing than all the uses of it; — so assuredly the very contemplation of things, as they are, without superstition or imposture, error or confusion, is in itself more worthy than all the fruit of inventions.

Lastly, if the debasement of arts and sciences to purposes of wickedness, luxury, and the like, be made a ground of objection, let no one be moved thereby. For the same may be said of all earthly goods; of wit, courage, strength, beauty, wealth, light itself, and the rest. Only let the human race recover that right over nature which belongs to it by divine bequest, and let power be given it; the exercise thereof will be governed by sound reason and true religion.

CXXX.

And now it is time for me to propound the art itself of interpreting nature; in which, although I conceive that I have given true and most useful precepts, yet I do not say either that it is absolutely necessary (as if nothing could be done without it) or that it is perfect. For I am of opinion that if men had ready at hand a

just history of nature and experience, and laboured diligently thereon; and if they could bind themselves to two rules, — the first, to lay aside received opinions and notions; and the second, to refrain the mind for a time from the highest generalisations, and those next to them, — they would be able by the native and genuine force of the mind, without any other art, to fall into my form of interpretation. For interpretation is the true and natural work of the mind when freed from impediments. It is true however that by my precepts everything will be in more readiness, and much more sure.

Nor again do I mean to say that no improvement can be made upon these. On the contrary, I that regard the mind not only in its own faculties, but in its connection with things, must needs hold that the art of discovery may advance as discoveries advance.

THE

SECOND BOOK

OF

APHORISMS.

THE SECOND BOOK OF

APHORISMS

CONCERNING

THE INTERPRETATION OF NATURE

AND

THE KINGDOM OF MAN.

Aphorism I.

On a given body to generate and superinduce a new nature or new natures, is the work and aim of Human Power. Of a given nature to discover the form, or true specific difference, or nature-engendering nature, or source of emanation (for these are the terms which come nearest to a description of the thing), is the work and aim of Human Knowledge. Subordinate to these primary works are two others that are secondary and of inferior mark; to the former, the transformation of concrete bodies, so far as this is possible; to the latter, the discovery, in every case of generation and motion, of the *latent process* carried on from the manifest efficient and the manifest material to the form which is engendered; and in like manner the discovery of the *latent configuration* of bodies at rest and not in motion.

II.

In what an ill condition human knowledge is at the present time, is apparent even from the commonly received maxims. It is a correct position that "true knowledge is knowledge by causes." And causes again are not improperly distributed into four kinds; the material, the formal, the efficient, and the final. But of these the final cause rather corrupts than advances the sciences, except such as have to do with human action. The discovery of the formal is despaired of. The efficient and the material (as they are investigated and received, that is, as remote causes, without reference to the latent process leading to the form) are but slight and superficial, and contribute little, if anything, to true and active science. Nor have I forgotten that in a former passage I noted and corrected as an error of the human mind the opinion that Forms give existence. For though in nature nothing really exists beside individual bodies, performing pure individual acts according to a fixed law, yet in philosophy this very law, and the investigation, discovery, and explanation of it, is the foundation as well of knowledge as of operation. And it is this law, with its clauses, that I mean when I speak of *Forms;* a name which I the rather adopt because it has grown into use and become familiar.

III.

If a man be acquainted with the cause of any nature (as whiteness or heat) in certain subjects only, his knowledge is imperfect; and if he be able to superinduce an effect on certain substances only (of those susceptible of such effect), his power is in like manner

imperfect. Now if a man's knowledge be confined to the efficient and material causes (which are unstable causes, and merely vehicles, or causes which convey the form in certain cases) he may arrive at new discoveries in reference to substances in some degree similar to one another, and selected beforehand; but he does not touch the deeper boundaries of things. But whosoever is acquainted with Forms, embraces the unity of nature in substances the most unlike; and is able therefore to detect and bring to light things never yet done, and such as neither the vicissitudes of nature, nor industry in experimenting, nor accident itself, would ever have brought into act, and which would never have occurred to the thought of man. From the discovery of Forms therefore results truth in speculation and freedom in operation.

IV.

Although the roads to human power and to human knowledge lie close together, and are nearly the same, nevertheless on account of the pernicious and inveterate habit of dwelling on abstractions, it is safer to begin and raise the sciences from those foundations which have relation to practice, and to let the active part itself be as the seal which prints and determines the contemplative counterpart. We must therefore consider, if a man wanted to generate and superinduce any nature upon a given body, what kind of rule or direction or guidance he would most wish for, and express the same in the simplest and least abstruse language. For instance, if a man wishes to superinduce upon silver the yellow colour of gold or an increase of weight (observing the laws of matter), or transparency on an opaque stone, or tenacity on glass, or vegetation on

some substance that is not vegetable, — we must consider, I say, what kind of rule or guidance he would most desire. And in the first place, he will undoubtedly wish to be directed to something which will not deceive him in the result, nor fail him in the trial. Secondly, he will wish for such a rule as shall not tie him down to certain means and particular modes of operation. For perhaps he may not have those means, nor be able conveniently to procure them. And if there be other means and other methods for producing the required nature (beside the one prescribed) these may perhaps be within his reach; and yet he shall be excluded by the narrowness of the rule, and get no good from them. Thirdly, he will desire something to be shown him, which is not as difficult as the thing proposed to be done, but comes nearer to practice.

For a true and perfect rule of operation then the direction will be *that it be certain, free, and disposing or leading to action.* And this is the same thing with the discovery of the true Form. For the Form of a nature is such, that given the Form the nature infallibly follows. Therefore it is always present when the nature is present, and universally implies it, and is constantly inherent in it. Again, the Form is such, that if it be taken away the nature infallibly vanishes. Therefore it is always absent when the nature is absent, and implies its absence, and inheres in nothing else. Lastly, the true Form is such that it deduces the given nature from some source of being which is inherent in more natures, and which is better known in the natural order of things than the Form itself. For a true and perfect axiom of knowledge then the direction and precept will be, *that another nature be discovered which is*

convertible with the given nature, and yet is a limitation of a more general nature, as of a true and real genus. Now these two directions, the one active the other contemplative, are one and the same thing; and what in operation is most useful, that in knowledge is most true.

V.

The rule or axiom for the transformation of bodies is of two kinds. The first regards a body as a troop or collection of simple natures. In gold, for example, the following properties meet. It is yellow in colour, heavy up to a certain weight; malleable or ductile to a certain degree of extension; it is not volatile, and loses none of its substance by the action of fire; it turns into a liquid with a certain degree of fluidity; it is separated and dissolved by particular means; and so on for the other natures which meet in gold. This kind of axiom, therefore, deduces the thing from the forms of simple natures. For he who knows the forms of yellow, weight, ductility, fixity, fluidity, solution, and so on, and the methods for superinducing them, and their gradations and modes, will make it his care to have them joined together in some body, whence may follow the transformation of that body into gold. And this kind of operation pertains to the first kind of action. For the principle of generating some one simple nature is the same as that of generating many; only that a man is more fettered and tied down in operation, if more are required, by reason of the difficulty of combining into one so many natures; which do not readily meet, except in the beaten and ordinary paths of nature. It must be said however that this mode of operation (which looks to simple natures

though in a compound body) proceeds from what in nature is constant and eternal and universal, and opens broad roads to human power, such as (in the present state of things) human thought can scarcely comprehend or anticipate.

The second kind of axiom, which is concerned with the discovery of the *latent process*, proceeds not by simple natures, but by compound bodies, as they are found in nature in its ordinary course. As, for instance, when inquiry is made, from what beginnings, and by what method and by what process, gold or any other metal or stone is generated, from its first menstrua and rudiments up to the perfect mineral; or in like manner by what process herbs are generated, from the first concretion of juices in the ground or from seeds up to the formed plant, with all the successive motions and diverse and continued efforts of nature. So also in the inquiry concerning the process of development in the generation of animals, from coition to birth; and in like manner of other bodies.

It is not however only to the generations of bodies that this investigation extends, but also to other motions and operations of nature. As, for instance, when inquiry is made concerning the whole course and continued action of nutrition, from the first reception of the food to its complete assimilation; or again, concerning the voluntary motion of animals, from the first impression on the imagination and the continued efforts of the spirit up to the bendings and movements of the limbs; or concerning the motion of the tongue and lips and other instruments, and the changes through which it passes till it comes to the utterance of articulate sounds. For these inquiries also relate to natures con-

crete or combined into one structure, and have regard to what may be called particular and special habits of nature, not to her fundamental and universal laws which constitute Forms. And yet it must be confessed that this plan appears to be readier and to lie nearer at hand and to give more ground for hope than the primary one.

In like manner the operative which answers to this speculative part, starting from the ordinary incidents of nature, extends its operation to things immediately adjoining, or at least not far removed. But as for any profound and radical operations on nature, they depend entirely on the primary axioms. And in those things too where man has no means of operating, but only of knowing, as in the heavenly bodies (for these he cannot operate upon or change or transform), the investigation of the fact itself or truth of the thing, no less than the knowledge of the causes and consents, must come from those primary and catholic axioms concerning simple natures; such as the nature of spontaneous rotation, of attraction or magnetism, and of many others which are of a more general form than the heavenly bodies themselves. For let no one hope to decide the question whether it is the earth or heaven that really revolves in the diurnal motion, until he has first comprehended the nature of spontaneous rotation.

VI.

But this Latent Process, of which I speak, is quite another thing than men, preoccupied as their minds now are, will easily conceive. For what I understand by it is not certain measures or signs or successive steps of process in bodies, which can be seen; but a process

perfectly continuous, which for the most part escapes the sense.

For instance; in all generation and transformation of bodies, we must inquire what is lost and escapes; what remains, what is added; what is expanded, what contracted; what is united, what separated; what is continued, what cut off; what propels, what hinders; what predominates, what yields; and a variety of other particulars.

Again, not only in the generation or transformation of bodies are these points to be ascertained, but also in all other alterations and motions it should in like manner be inquired what goes before, what comes after; what is quicker, what more tardy; what produces, what governs motion; and like points; all which nevertheless in the present state of the sciences (the texture of which is as rude as possible and good for nothing) are unknown and unhandled. For seeing that every natural action depends on things infinitely small, or at least too small to strike the sense, no one can hope to govern or change nature until he has duly comprehended and observed them.

VII.

In like manner the investigation and discovery of the *latent configuration* in bodies is a new thing, no less than the discovery of the Latent Process and of the Form. For as yet we are but lingering in the outer courts of nature, nor are we preparing ourselves a way into her inner chambers. Yet no one can endow a given body with a new nature, or successfully and aptly transmute it into a new body, unless he has attained a competent knowledge of the body so to be

altered or transformed. Otherwise he will run into methods which, if not useless, are at any rate difficult and perverse and unsuitable to the nature of the body on which he is operating. It is clear therefore that to this also a way must be opened and laid out.

And it is true that upon the anatomy of organised bodies (as of man and animals) some pains have been well bestowed and with good effect; and a subtle thing it seems to be, and a good scrutiny of nature. Yet this kind of anatomy is subject to sight and sense, and has place only in organised bodies. And besides it is a thing obvious and easy, when compared with the true anatomy of the Latent Configuration in bodies which are thought to be of uniform structure; especially in things that have a specific character and their parts, as iron, stone; and again in parts of uniform structure in plants and animals, as the root, the leaf, the flower, flesh, blood, and bones. But even in this kind, human industry has not been altogether wanting; for this is the very thing aimed at in the separation of bodies of uniform structure by means of distillations and other modes of analysis; that the complex structure of the compound may be made apparent by bringing together its several homogeneous parts. And this is of use too, and conduces to the object we are seeking; although too often fallacious in its results, because many natures which are in fact newly brought out and superinduced by fire and heat and other modes of solution are taken to be the effect of separation merely, and to have subsisted in the compound before. And after all, this is but a small part of the work of discovering the true Configuration in the compound body; which Configuration is a thing far more subtle and exact, and such

as the operation of fire rather confounds than brings out and makes distinct.

Therefore a separation and solution of bodies must be effected, not by fire indeed, but by reasoning and true induction, with experiments to aid; and by a comparison with other bodies, and a reduction to simple natures and their Forms, which meet and mix in the compound. In a word we must pass from Vulcan to Minerva, if we intend to bring to light the true textures and configurations of bodies; on which all the occult and, as they are called, specific properties and virtues in things depend; and from which too the rule of every powerful alteration and transformation is derived.

For example, we must inquire what amount of spirit there is in every body, what of tangible essence; and of the spirit, whether it be copious and turgid, or meagre and scarce; whether it be fine or coarse, akin to air or to fire, brisk or sluggish, weak or strong, progressive or retrograde, interrupted or continuous, agreeing with external and surrounding objects or disagreeing, &c. In like manner we must inquire into the tangible essence (which admits of no fewer differences than the spirit), into its coats, its fibres, its kinds of texture. Moreover the disposition of the spirit throughout the corporeal frame, with its pores, passages, veins and cells, and the rudiments or first essays of the organised body, fall under the same investigation. But on these inquiries also, and I may say on all the discovery of the Latent Configuration, a true and clear light is shed by the primary axioms, which entirely dispels all darkness and subtlety.

VIII.

Nor shall we thus be led to the doctrine of atoms, which implies the hypothesis of a vacuum and that of the unchangeableness of matter (both false assumptions); we shall be led only to real particles, such as really exist. Nor again is there any reason to be alarmed at the subtlety of the investigation, as if it could not be disentangled; on the contrary, the nearer it approaches to simple natures, the easier and plainer will everything become; the business being transferred from the complicated to the simple; from the incommensurable to the commensurable; from surds to rational quantities; from the infinite and vague to the finite and certain; as in the case of the letters of the alphabet and the notes of music. And inquiries into nature have the best result, when they begin with physics and end in mathematics. Again, let no one be afraid of high numbers or minute fractions. For in dealing with numbers it is as easy to set down or conceive a thousand as one, or the thousandth part of an integer as an integer itself.

IX.

From the two kinds of axioms which have been spoken of, arises a just division of philosophy and the sciences; taking the received terms (which come nearest to express the thing) in a sense agreeable to my own views. Thus, let the investigation of Forms, which are (in the eye of reason at least, and in their essential law) eternal and immutable, constitute *Metaphysics;* and let the investigation of the Efficient Cause, and of Matter, and of the Latent Process, and

the Latent Configuration (all of which have reference to the common and ordinary course of nature, not to her eternal and fundamental laws) constitute *Physics*. And to these let there be subordinate two practical divisions: to Physics, *Mechanics;* to Metaphysics, what (in a purer sense of the word) I call *Magic*, on account of the broadness of the ways it moves in, and its greater command over nature.

X.

Having thus set up the mark of knowledge, we must go on to precepts, and that in the most direct and obvious order. Now my directions for the interpretation of nature embrace two generic divisions; the one how to educe and form axioms from experience; the other how to deduce and derive new experiments from axioms. The former again is divided into three ministrations; a ministration to the sense, a ministration to the memory, and a ministration to the mind or reason.

For first of all we must prepare a *Natural and Experimental History*, sufficient and good; and this is the foundation of all; for we are not to imagine or suppose, but to discover, what nature does or may be made to do.

But natural and experimental history is so various and diffuse, that it confounds and distracts the understanding, unless it be ranged and presented to view in a suitable order. We must therefore form *Tables and Arrangements of Instances*, in such a method and order that the understanding may be able to deal with them.

And even when this is done, still the understanding, if left to itself and its own spontaneous movements, is

incompetent and unfit to form axioms, unless it be directed and guarded. Therefore in the third place we must use *Induction*, true and legitimate induction, which is the very key of interpretation. But of this, which is the last, I must speak first, and then go back to the other ministrations.

XI.

The investigation of Forms proceeds thus: a nature being given, we must first of all have a muster or presentation before the understanding of all known instances which agree in the same nature, though in substances the most unlike. And such collection must be made in the manner of a history, without premature speculation, or any great amount of subtlety. For example, let the investigation be into the Form of Heat.

Instances Agreeing in the Nature of Heat.

1. The rays of the sun, especially in summer and at noon.
2. The rays of the sun reflected and condensed, as between mountains, or on walls, and most of all in burning-glasses and mirrors.
3. Fiery meteors.
4. Burning thunderbolts.
5. Eruptions of flame from the cavities of mountains.
6. All flame.
7. Ignited solids.
8. Natural warm-baths.
9. Liquids boiling or heated.
10. Hot vapours and fumes, and the air itself, which

conceives the most powerful and glowing heat, if confined; as in reverbatory furnaces.

11. Certain seasons that are fine and cloudless by the constitution of the air itself, without regard to the time of year.

12. Air confined and underground in some caverns, especially in winter.

13. All villous substances, as wool, skins of animals, and down of birds, have heat.

14. All bodies, whether solid or liquid, whether dense or rare (as the air itself is), held for a time near the fire.

15. Sparks struck from flint and steel by strong percussion.

16. All bodies rubbed violently, as stone, wood, cloth, &c., insomuch that poles and axles of wheels sometimes catch fire; and the way they kindled fire in the West Indies was by attrition.

17. Green and moist vegetables confined and bruised together, as roses packed in baskets; insomuch that hay, if damp when stacked, often catches fire.

18. Quick lime sprinkled with water.

19. Iron, when first dissolved by strong waters in glass, and that without being put near the fire. And in like manner tin, &c., but not with equal intensity.

20. Animals, especially and at all times internally; though in insects the heat is not perceptible to the touch by reason of the smallness of their size.

21. Horse-dung and like excrements of animals when fresh.

22. Strong oil of sulphur and of vitriol has the effect of heat in burning linen.

23. Oil of marjoram and similar oils have the effect of heat in burning the bones of the teeth.

24. Strong and well rectified spirit of wine has the effect of heat; insomuch that the white of an egg being put into it hardens and whitens almost as if it were boiled; and bread thrown in becomes dry and crusted like toast.

25. Aromatic and hot herbs, as *dracunculus*, *nasturtium vetus*, &c., although not warm to the hand (either whole or in powder), yet to the tongue and palate, being a little masticated, they feel hot and burning.

26. Strong vinegar, and all acids, on all parts of the body where there is no epidermis, as the eye, tongue; or on any part when wounded and laid bare of the skin; produce a pain but little differing from that which is created by heat.

27. Even keen and intense cold produces a kind of sensation of burning;

Nec Boreæ penetrabile frigus adurit.[1]

28. Other instances.

This table I call the *Table of Essence and Presence.*

XII.

Secondly, we must make a presentation to the understanding of instances in which the given nature is wanting; because the Form, as stated above, ought no less to be absent when the given nature is absent, than present when it is present. But to note all these would be endless.

The negatives should therefore be subjoined to the affirmatives, and the absence of the given nature in-

[1] Nor burns the sharp cold of the northern blast.

quired of in those subjects only that are most akin to the others in which it is present and forthcoming. This I call the *Table of Deviation, or of Absence in Proximity.*

Instances in Proximity where the Nature of Heat is Absent.

Answering to the first affirmative instance. 1. The rays of the moon and of stars and comets are not found to be hot to the touch; indeed the severest colds are observed to be at the full moons.

The larger fixed stars however, when passed or approached by the sun, are supposed to increase and give intensity to the heat of the sun; as is the case when the sun is in the sign Leo, and in the Dog-days.

To the 2nd. 2. The rays of the sun in what is called the middle region of the air do not give heat; for which there is commonly assigned not a bad reason, viz. that that region is neither near enough to the body of the sun from which the rays emanate, nor to the earth from which they are reflected. And this appears from the fact that on the tops of mountains, unless they are very high, there is perpetual snow. On the other hand it has been observed that on the peak of Teneriffe, and among the Andes of Peru, the very tops of the mountains are free from snow; which lies only somewhat lower down. Moreover the air itself at the very top is found to be by no means cold, but only rare and keen; insomuch that on the Andes it pricks and hurts the eyes by its excessive keenness, and also irritates the mouth of the stomach, producing vomiting. And it was observed by the ancients that on the top of Olympus the rarity of the air was such that those who ascended it had to carry sponges with them dipped in

vinegar and water, and to apply them from time to time to their mouth and nose, the air being from its rarity not sufficient to support respiration; and it was further stated that on this summit the air was so serene, and so free from rain and snow and wind, that letters traced by the finger in the ashes of the sacrifices on the altar of Jupiter remained there till the next year without being at all disturbed. And at this day travellers ascending to the top of the Peak of Teneriffe make the ascent by night and not by day; and soon after the rising of the sun are warned and urged by their guides to come down without delay, on account of the danger they run lest the animal spirits should swoon and be suffocated by the tenuity of the air.

To the 2nd. 3. The reflexion of the rays of the sun in regions near the polar circles is found to be very weak and ineffective in producing heat; insomuch that the Dutch who wintered in Nova Zembla, and expected their ship to be freed from the obstructions of the mass of ice which hemmed her in by the beginning of July, were disappointed of their expectation, and obliged to take to their boat. Thus the direct rays of the sun seem to have but little power, even on the level ground; nor have the reflex much, unless they are multiplied and combined; which is the case when the sun tends more to the perpendicular; for then the incident rays make acuter angles, so that the lines of the rays are nearer each other; whereas on the contrary, when the sun shines very obliquely, the angles are very obtuse, and thus the lines of rays are at a greater distance from each other. Meanwhile it should be observed that there may be many operations of the sun, and those too depending on the nature of heat, which are not propor-

tioned to our touch; so that in respect of us their action does not go so far as to produce sensible warmth, but in respect of some other bodies they have the effect of heat.

To the 2nd. 4. Try the following experiment. Take a glass fashioned in a contrary manner to a common burning-glass, and placing it between your hand and the rays of the sun, observe whether it diminishes the heat of the sun, as a burning-glass increases and strengthens it. For it is evident in the case of optical rays that according as the glass is made thicker or thinner in the middle as compared with the sides, so do the objects seen through it appear more spread or more contracted. Observe therefore whether the same is the case with heat.

To the 2nd. 5. Let the experiment be carefully tried, whether by means of the most powerful and best constructed burning glasses, the rays of the moon can be so caught and collected as to produce even the least degree of warmth. But should this degree of warmth prove too subtle and weak to be perceived and apprehended by the touch, recourse must be had to those glasses which indicate the state of the atmosphere in respect of heat and cold. Thus, let the rays of the moon fall through a burning-glass on the top of a glass of this kind, and then observe whether there ensues a sinking of the water through warmth.

To the 2nd. 6. Let a burning-glass also be tried with a heat that does not emit rays or light, as that of iron or stone heated but not ignited, boiling water, and the like; and observe whether there ensue an increase of the heat, as in the case of the sun's rays.

To the 2nd. 7. Let a burning-glass also be tried with common flame.

To the 3rd. 8. Comets (if we are to reckon these too among meteors) are not found to exert a constant or manifest effect in increasing the heat of the season, though it is observed that they are often followed by droughts. Moreover bright beams and pillars and openings in the heavens appear more frequently in winter than in summer time, and chiefly during the intensest cold, but always accompanied by dry weather. Lightning, however, and coruscations and thunder, seldom occur in the winter, but about the time of great heat. Falling stars, as they are called, are commonly supposed to consist rather of some bright and lighted viscous substance, than to be of any strong fiery nature. But on this point let further inquiry be made.

To the 4th. 9. There are certain coruscations which give light but do not burn. And these always come without thunder.

To the 5th. 10. Eructations and eruptions of flame are found no less in cold than in warm countries, as in Iceland and Greenland. In cold countries too the trees are in many cases more inflammable and more pitchy and resinous than in warm; as the fir, pine, and others. The situations however and the nature of the soil in which eruptions of this kind usually occur have not been carefully enough ascertained to enable us to subjoin a Negative to this Affirmative Instance.

To the 6th. 11. All flame is in all cases more or less warm; nor is there any Negative to be subjoined. And yet they say that the *ignis fatuus* (as it is called), which sometimes even settles on a wall, has not much heat; perhaps as much as the flame of spirit of wine, which is mild and soft. But still milder must that flame be, which according to certain grave and trust-

worthy histories has been seen shining about the head and locks of boys and girls, without at all burning the hair, but softly playing round it. It is also most certain that about a horse, when sweating on the road, there is sometimes seen at night, and in clear weather, a sort of luminous appearance without any manifest heat. And it is a well known fact, and looked upon as a sort of miracle, that a few years ago a girl's stomacher, on being slightly shaken or rubbed, emitted sparks; which was caused perhaps by some alum or salts used in the dye, that stood somewhat thick and formed a crust, and were broken by the friction. It is also most certain that all sugar, whether refined or raw, provided only it be somewhat hard, sparkles when broken or scraped with a knife in the dark. In like manner sea and salt water is sometimes found to sparkle by night when struck violently by oars. And in storms too at night time, the foam of the sea when violently agitated emits sparks, and this sparkling the Spaniards call *Sea Lung*. With regard to the heat of the flame which was called by ancient sailors Castor and Pollux, and by moderns St. Elmo's Fire, no sufficient investigation thereof has been made.

To the 7th. 12. Every body ignited so as to turn to a fiery red, even if unaccompanied by flame, is always hot; neither is there any Negative to be subjoined to this Affirmative. But that which comes nearest seems to be rotten wood, which shines by night, and yet is not found to be hot; and the putrifying scales of fish, which also shine in the dark, and yet are not warm to the touch; nor again is the body of the glow-worm, or of the fly called *Luciola*, found to be warm to the touch.

To the 8th. 13. In what situation and kind of soil warm baths usually spring, has not been sufficiently examined; and therefore no Negative is subjoined.

To the 9th. 14. To warm liquids I subjoin the Negative Instance of liquid itself in its natural state. For we find no tangible liquid which is warm in its own nature and remains so constantly; but the warmth is an adventitious nature, superinduced only for the time being; so that the liquids which in power and operation are hottest, as spirit of wine, chemical oil of spices, oil of vitriol and sulphur, and the like, which burn after a while, are at first cold to the touch. The water of natural warm baths on the other hand, if received into a vessel and separated from its springs, cools just like water that has been heated on a fire. But it is true that oily substances are less cold to the touch than watery, oil being less cold than water, and silk than linen. But this belongs to the Table of Degrees of Cold.

To the 10th. 15. In like manner to hot vapour I subjoin as a Negative the nature of vapour itself, such as we find it with us. For exhalations from oily substances, though easily inflammable, are yet not found to be warm, unless newly exhaled from the warm body.

To the 10th. 16. In like manner I subjoin as a Negative to hot air the nature of air itself. For we do not find here any air that is warm, unless it has either been confined, or compressed, or manifestly warmed by the sun, fire, or some other warm substance.

To the 11th. 17. I here subjoin the Negative of colder weather than is suitable to the season of the year, which we find occurs during east and north winds; just as we have weather of the opposite kind with the

south and west winds. So a tendency to rain, especially in winter time, accompanies warm weather; while frost accompanies cold.

To the 12th. 18. Here I subjoin the Negative of air confined in caverns during the summer. But the subject of air in confinement should by all means be more diligently examined. For in the first place it may well be matter of doubt what is the nature of air in itself with regard to heat and cold. For air manifestly receives warmth from the influence of the heavenly bodies, and cold perhaps from the exhalations of the earth; and again in the middle region of air, as it is called, from cold vapours and snow; so that no opinion can be formed as to the nature of air from the examination of air that is at large and exposed; but a truer judgment might be made by examining it when confined. It is however necessary for the air to be confined in a vessel of such material as will not itself communicate warmth or cold to the air by its own nature, nor readily admit the influence of the outer atmosphere. Let the experiment therefore be made in an earthen jar wrapped round with many folds of leather to protect it from the outward air, and let the vessel remain tightly closed for three or four days; then open the vessel and test the degree of heat or cold by applying either the hand or a graduated glass.

To the 13th. 19. In like manner a doubt suggests itself, whether the warmth in wool, skins, feathers, and the like, proceeds from a faint degree of heat inherent in them, as being excretions from animals; or from a certain fat and oiliness, which is of a nature akin to warmth; or simply, as surmised in the preceding article, from the confinement and separation of the air.

For all air that is cut off from connexion with the outer air seems to have some warmth. Try the experiment therefore with fibrous substances made of linen; not of wool, feathers, or silk, which are excretions from animals. It should also be observed that all powders (in which there is manifestly air enclosed) are less cold than the whole substances they are made from; as likewise I suppose that all froth (as that which contains air) is less cold than the liquor it comes from.

To the 14th. 20. To this no Negative is subjoined. For there is nothing found among us either tangible or spirituous which does not contract warmth when put near fire. There is this difference however, that some substances contract warmth more quickly, as air, oil, and water; others more slowly, as stone and metal. But this belongs to the Table of Degrees.

To the 15th. 21. To this Instance I subjoin no Negative, except that I would have it well observed that sparks are produced from flint and steel, or any other hard substance, only when certain minute particles are struck off from the substance of the stone or metal; and that the attrition of the air does not of itself ever produce sparks, as is commonly supposed. And the sparks themselves too, owing to the weight of the ignited body, tend rather downwards than upwards; and on going out become a tangible sooty substance.

To the 16th. 22. There is no Negative, I think, to be subjoined to this Instance. For we find among us no tangible body which does not manifestly gain warmth by attrition; insomuch that the ancients fancied that the heavenly bodies had no other means or power of producing warmth than by the attrition of the air in

their rapid and hurried revolution. But on this subject we must further inquire whether bodies discharged from engines, as balls from cannon, do not acquire some degree of heat from the very percussion, so as to be found somewhat warm when they fall. Air in motion, however, rather chills than warms, as appears from wind, bellows, and blowing with the mouth contracted. But motion of this kind is not so rapid as to excite heat, and is the motion of a mass, and not of particles; so that it is no wonder if it does not generate heat.

To the 17th. 23. On this Instance should be made more diligent inquiry. For herbs and vegetables when green and moist seem to contain some latent heat, though so slight that it is not perceptible to the touch when they are single; but only when they are collected and shut up together, so that their spirits may not breathe out into the air, but may mutually cherish each other; whereupon there arises a palpable heat, and sometimes flame in suitable matter.

To the 18th 24. On this Instance too should be made more diligent inquiry. For quick lime sprinkled with water seems to contract heat, either by the concentration of heat before dispersed, as in the above-mentioned case of confined herbs, or because the igneous spirit is irritated and exasperated by the water, so as to cause a conflict and reaction. Which of these two is the real cause will more readily appear if oil be poured on instead of water; for oil will serve equally well with water to concentrate the enclosed spirit, but not to irritate it. We should also extend the experiment both by employing the ashes and rusts of different bodies, and by pouring in different liquids.

To the 19th. 25. To this Instance is subjoined the Neg-

ative of other metals which are softer and more fusible. For gold-leaf dissolved by *aqua regia* gives no heat to the touch; no more does lead dissolved in *aqua fortis;* neither again does quicksilver (as I remember); but silver itself does, and copper too (as I remember); tin still more manifestly; and most of all iron and steel, which not only excite a strong heat in dissolution, but also a violent ebullition. It appears therefore that the heat is produced by conflict; the strong waters penetrating, digging into, and tearing asunder the parts of the substance, while the substance itself resists. But where the substances yield more easily, there is hardly any heat excited.

To the 20th. 26. To the heat of animals no Negative is subjoined, except that of insects (as above-mentioned), on account of their small size. For in fishes, as compared with land animals, it is rather a low degree than an absence of heat that is noted. But in vegetables and plants there is no degree of heat perceptible to the touch, either in their exudations or in their pith when freshly exposed. In animals however is found a great diversity of heat, both in their parts (there being different degrees of heat about the heart, in the brain, and on the skin) and in their accidents, as violent exercise and fevers.

To the 21st. 27. To this Instance it is hard to subjoin a Negative. Indeed the excrements of animals when no longer fresh have manifestly a potential heat, as is seen in the enriching of soil.

To the 22nd and 23rd. 28. Liquids, whether waters or oils, which possess a great and intense acridity, act like heat in tearing asunder bodies, and burning them after some time; yet to the touch they are not hot at first. But

their operation is relative and according to the porosity of the body to which they are applied. For *aqua regia* dissolves gold but not silver; *aqua fortis*, on the contrary, dissolves silver, but not gold; neither dissolves glass, and so on with others.

To the 24th. 29. Let trial be made of spirit of wine on wood; and also on butter, wax, or pitch; and observe whether by its heat it in any degree melts them. For the twenty-fourth instance exhibits a power in it that resembles heat in producing incrustation. In like manner therefore try its power in producing liquefaction. Let trial also be made with a graduated or calendar glass, hollow at the top; pour into the hollow spirit of wine well rectified, cover it up that the spirit may better retain its heat, and observe whether by its heat it makes the water sink.

To the 25th. 30. Spices and acrid herbs strike hot on the palate, and much hotter on the stomach. Observe therefore on what other substances they produce the effects of heat. Sailors tell us that when large parcels and masses of spices are, after being long kept close, suddenly opened, those who first stir and take them out run the risk of fever and inflammation. It can also be tried whether such spices and herbs when pounded would not dry bacon and meat hung over them, as smoke does.

To the 26th. 31. There is an acridity or pungency both in cold things, as vinegar and oil of vitriol, and in hot, as oil of marjoram and the like. Both alike therefore cause pain in animate substances, and tear asunder and consume the parts in such as are inanimate. To this Instance again there is no Negative subjoined. Moreover we find no pain in animals, save with a certain sensation of heat.

To the 27th. 32. There are many actions common both to heat and cold, though in a very different manner. For boys find that snow after a while seems to burn their hands; and cold preserves meat from putrefaction, no less than fire; and heat contracts bodies, which cold does also. But these and similar instances may more conveniently be referred to the inquiry concerning Cold.

XIII.

Thirdly, we must make a presentation to the understanding of instances in which the nature under inquiry is found in different degrees, more or less; which must be done by making a comparison either of its increase and decrease in the same subject, or of its amount in different subjects, as compared one with another. For since the Form of a thing is the very thing itself, and the thing differs from the form no otherwise than as the apparent differs from the real, or the external from the internal, or the thing in reference to man from the thing in reference to the universe; it necessarily follows that no nature can be taken as the true form, unless it always decrease when the nature in question decreases, and in like manner always increase when the nature in question increases. This Table therefore I call the *Table of Degrees* or the *Table of Comparison.*

Table of Degrees or Comparison in Heat.

I will therefore first speak of those substances which contain no degree at all of heat perceptible to the touch, but seem to have a certain potential heat only, or disposition and preparation for hotness. After that I shall proceed to substances which are hot actually, and to the touch, and to their intensities and degrees.

1. In solid and tangible bodies we find nothing which is in its nature originally hot. For no stone, metal, sulphur, fossil, wood, water, or carcass of animal is found to be hot. And the hot water in baths seems to be heated by external causes; whether it be by flame or subterraneous fire, such as is thrown up from Ætna and many other mountains, or by the conflict of bodies, as heat is caused in the dissolutions of iron and tin. There is therefore no degree of heat palpable to the touch in animate substances; but they differ in degree of cold, wood not being equally cold with metal. But this belongs to the Table of Degrees in Cold.

2. As far however as potential heat and aptitude for flame is concerned, there are many inanimate substances found strongly disposed thereto, as sulphur, naphtha, rock oil.

3. Substances once hot, as horse-dung from animal heat, and lime or perhaps ashes and soot from fire, retain some latent remains of their former heat. Hence certain distillations and resolutions of bodies are made by burying them in horse-dung, and heat is excited in lime by sprinkling it with water, as already mentioned.

4. In the vegetable creation we find no plant or part of plant (as gum or pitch) which is warm to the human touch. But yet, as stated above, green herbs gain warmth by being shut up; and to the internal touch, as the palate or stomach, and even to external parts, after a little time, as in plasters and ointments, some vegetables are perceptibly warm and others cold.

5. In the parts of animals after death or separation from the body, we find nothing warm to the human touch. Not even horse-dung, unless enclosed and

buried, retains its heat. But yet all dung seems to have a potential heat, as is seen in the fattening of the land. In like manner carcasses of animals have some such latent and potential heat; insomuch that in burying grounds, where burials take place daily, the earth collects a certain hidden heat, which consumes a body newly laid in it much more speedily than pure earth. We are told too that in the East there is discovered a fine soft texture, made of the down of birds, which by an innate force dissolves and melts butter when lightly wrapped in it.

6. Substances which fatten the soil, as dung of all kinds, chalk, sea-sand, salt, and the like, have some disposition to heat.

7. All putrefaction contains in itself certain elements of a slight heat, though not so much as to be perceived by the touch. For not even those substances which on putrefaction turn to animalculæ, as flesh, cheese, &c., feel warm to the touch; no more does rotten wood, which shines in the dark. Heat however in putrid substances sometimes betrays itself by foul and powerful odours.

8. The first degree of heat therefore among those substances which feel hot to the touch, seems to be the heat of animals, which has a pretty great extent in its degrees. For the lowest, as in insects, is hardly perceptible to the touch; but the highest scarce equals the sun's heat in the hottest countries and seasons, nor is it too great to be borne by the hand. It is said however of Constantius, and some others of a very dry constitution and habit of body, that in violent fevers they became so hot as somewhat to burn the hand that touched them.

9. Animals increase in heat by motion and exercise, wine, feasting, venus, burning fevers, and pain.

10. When attacked by intermittent fevers, animals are at first seized with cold and shivering, but soon after they become exceedingly hot, which is their condition from the first in burning and pestilential fevers.

11. Let further inquiry be made into the different degrees of heat in different animals, as in fishes, quadrupeds, serpents, birds; and also according to their species, as in the lion, the kite, the man; for in common opinion fish are the least hot internally, and birds the hottest; especially doves, hawks, and sparrows.

12. Let further inquiry be made into the different degrees of heat in the different parts and limbs of the same animal. For milk, blood, seed, eggs, are found to be hot only in a moderate degree, and less hot than the outer flesh of the animal when in motion or agitated. But what the degree of heat is in the brain, stomach, heart, &c. has not yet been in like manner inquired.

13. All animals in winter and cold weather are cold externally, but internally they are thought to be even hotter.

14. The heat of the heavenly bodies, even in the hottest countries, and at the hottest times of the year and day, is never sufficiently strong to set on fire or burn the driest wood or straw, or even tinder, unless strengthened by burning-glasses or mirrors. It is however able to extract vapour from moist substances.

15. By the tradition of astronomers some stars are hotter than others. Of planets, Mars is accounted the hottest after the sun; then comes Jupiter, and then Venus. Others, again, are set down as cold; the

moon, for instance, and above all Saturn. Of fixed stars, Sirius is said to be the hottest, then Cor Leonis or Regulus, then Canicula, and so on.

16. The sun gives greater heat the nearer he approaches to the perpendicular or zenith; and this is probably true of the other planets also, according to the proportion of their heat. Jupiter, for instance, is hotter, probably, to us when under Cancer or Leo than under Capricorn or Aquarius.

17. We must also believe that the sun and other planets give more heat in perigee, from their proximity to the earth, than they do in apogee. But if it happens that in some region the sun is at the same time in perigee and near the perpendicular, his heat must of necessity be greater than in a region where he is also in perigee, but shining more obliquely. And therefore the altitude of the planets in their exaltation in different regions ought to be noted, with respect to perpendicularity or obliquity.

18. The sun and other planets are supposed to give greater heat when nearer to the larger fixed stars. Thus when the sun is in Leo he is nearer Cor Leonis, Cauda Leonis, Spica Virginis, Sirius and Canicula, than when he is in Cancer, in which sign however he is nearer to the perpendicular. And it must be supposed that those parts of the heavens shed the greatest heat (though it be not at all perceptible to the touch) which are the most adorned with stars, especially of a larger size.

19. Altogether, the heat of the heavenly bodies is increased in three ways; first, by perpendicularity; secondly, by proximity or perigee; thirdly, by the conjunction or combination of stars.

20. The heat of animals, and of the rays of the heavenly bodies also (as they reach us), is found to differ by a wide interval from flame, though of the mildest kind, and from all ignited bodies; and from liquids also, and air itself when highly heated by fire. For the flame of spirit of wine, though scattered and not condensed, is yet sufficient to set paper, straw, or linen on fire; which the heat of animals will never do, or of the sun without a burning-glass or mirror.

21. There are however many degrees of strength and weakness in the heat of flame and ignited bodies. But as they have never been diligently inquired into, we must pass them lightly over. It appears however that of all flame that of spirit of wine is the softest, unless perhaps *ignis fatuus* be softer, and the flames or sparklings arising from the sweat of animals. Next to this, as I suppose, comes flame from light and porous vegetable matter, as straw, reeds, and dried leaves; from which the flame from hairs or feathers does not much differ. Next perhaps comes flame from wood, especially such as contains but little rosin or pitch; with this distinction however, that the flame from small pieces of wood (such as are commonly tied up in fagots) is milder than the flame from trunks and roots of trees. And this you may try any day in furnaces for smelting iron, in which a fire made with fagots and boughs of trees is of no great use. After this I think comes flame from oil, tallow, wax, and such like fat and oily substances, which have no great acrimony. But the most violent heat is found in pitch and rosin; and yet more in sulphur, camphor, naphtha, rock-oil, and salts (after the crude matter is discharged), and in their compounds, as gunpowder, Greek fire (commonly

called wild fire), and its different kinds, which have so stubborn a heat that they are not easily extinguished by water.

22. I think also that the flame which results from some imperfect metals is very strong and eager. But on these points let further inquiry be made.

23. The flame of powerful lightning seems to exceed in strength all the former; for it has even been known to melt wrought iron into drops; which those other flames cannot do.

24. In ignited bodies too there are different degrees of heat, though these again have not yet been diligently examined. The weakest heat of all, I think, is that from tinder, such as we use to kindle flame with; and in like manner that of touchwood or tow, which is used in firing cannon. After this comes ignited wood or coal, and also bricks and the like heated to ignition. But of all ignited substances, the hottest, as I take it, are ignited metals; as iron, copper, &c. But these require further investigation.

25. Some ignited bodies are found to be much hotter than some flames. Ignited iron, for instance, is much hotter and more consuming than flame of spirit of wine.

26. Of substances also which are not ignited but only heated by fire, as boiling water and air confined in furnaces, some are found to exceed in heat many flames and ignited substances.

27. Motion increases heat, as you may see in bellows, and by blowing; insomuch that the harder metals are not dissolved or melted by a dead or quiet fire, till it be made intense by blowing.

28. Let trial be made with burning-glasses, which

(as I remember) act thus. If you place a burning-glass at the distance of (say) a span from a combustible body, it will not burn or consume it so easily as if it were first placed at the distance of (say) half a span, and then moved gradually and slowly to the distance of the whole span. And yet the cone and union of rays are the same; but the motion itself increases the operation of the heat.

29. Fires which break out during a strong wind are thought to make greater progress against than with it; because the flame recoils more violently when the wind gives way than it advances while the wind is driving it on.

30. Flame does not burst out, nor is it generated, unless some hollow space be allowed it to move and play in; except the explosive flame of gunpowder, and the like, where compression and imprisonment increase its fury.

31. An anvil grows very hot under the hammer, insomuch that if it were made of a thin plate it might, I suppose, with strong and continuous blows of the hammer, grow red like ignited iron. But let this be tried by experiment.

32. But in ignited substances which are porous, so as to give the fire room to move, if this motion be checked by strong compression, the fire is immediately extinguished. For instance, when tinder, or the burning wick of a candle or lamp, or even live charcoal or coal, is pressed down with an extinguisher, or with the foot, or any similar instrument, the operation of the fire instantly ceases.

33. Approximation to a hot body increases heat in proportion to the degree of approximation. And this

is the case also with light; for the nearer an object is brought to the light, the more visible it becomes.

34. The union of different heats increases heat, unless the hot substances be mixed together. For a large fire and a small fire in the same room increase one another's heat; but warm water plunged into boiling water cools it.

35. The continued application of a hot body increases heat, because heat perpetually passing and emanating from it mingles with the previously existing heat, and so multiplies the heat. For a fire does not warm a room as well in half an hour as it does if continued through the whole hour. But this is not the case with light; for a lamp or candle gives no more light after it has been long lighted, than it did at first.

36. Irritation by surrounding cold increases heat, as you may see in fires during a sharp frost. And this I think is owing not merely to the confinement and contraction of the heat, which is a kind of union, but also to irritation. Thus when air or a stick is violently compressed or bent, it recoils not merely to the point it was forced from, but beyond it on the other side. Let trial therefore be carefully made by putting a stick or some such thing into flame, and observing whether it is not burnt more quickly at the sides than in the middle of the flame.

37. There are many degrees in susceptibility of heat. And first of all it is to be observed how slight and faint a heat changes and somewhat warms even those bodies which are least of all susceptible of heat. Even the heat of the hand communicates some heat to a ball of lead or any metal, if held in it a little while. So readily and so universally is heat transmitted and excited, the body remaining to all appearance unchanged.

38. Of all substances that we are acquainted with, the one which most readily receives and loses heat is air; as is best seen in calendar glasses [air thermoscopes], which are made thus. Take a glass with a hollow belly, a thin and oblong neck; turn it upside down and lower it, with the mouth downwards and the belly upwards, into another glass vessel containing water; and let the mouth of the inserted vessel touch the bottom of the receiving vessel, and its neck lean slightly against the mouth of the other, so that it can stand. And that this may be done more conveniently, apply a little wax to the mouth of the receiving glass, but not so as to seal its mouth quite up; in order that the motion, of which we are going to speak, and which is very facile and delicate, may not be impeded by want of a supply of air.

The lowered glass, before being inserted into the other, must be heated before a fire in its upper part, that is its belly. Now when it is placed in the position I have described, the air which was dilated by the heat will, after a lapse of time sufficient to allow for the extinction of that adventitious heat, withdraw and contract itself to the same extension or dimension as that of the surrounding air at the time of the immersion of the glass; and will draw the water upwards to a corresponding height. To the side of the glass there should be affixed a strip of paper, narrow and oblong, and marked with as many degrees as you choose. You will then see, according as the day is warm or cold, that the air contracts under the action of cold, and expands under the action of heat; as will be seen by the water rising when the air contracts, and sinking when it dilates. But the air's sense of heat and cold is so subtle and exquisite as far to exceed the perception of

the human touch, insomuch that a ray of sunshine, or the heat of the breath, much more the heat of one's hand placed on the top of the glass, will cause the water immediately to sink in a perceptible degree. And yet I think that animal spirits have a sense of heat and cold more exquisite still, were it not that it is impeded and deadened by the grossness of the body.

39. Next to air, I take those bodies to be most sensitive of heat which have been recently changed and compressed by cold, as snow and ice; for they begin to dissolve and melt with any gentle heat. Next to them, perhaps, comes quicksilver. After that follow greasy substances, as oil, butter, and the like; then comes wood; then water; and lastly stones and metals, which are slow to heat, especially in the inside. These, however, when once they have acquired heat retain it very long; in so much that an ignited brick, stone, or piece of iron, when plunged into a basin of water, will remain for a quarter of an hour, or thereabouts, so hot that you cannot touch it.

40. The less the mass of a body, the sooner is it heated by the approach of a hot body; which shows that all heat of which we have experience is in some sort opposed to tangible matter.

41. Heat, as far as regards the sense and touch of man, is a thing various and relative; insomuch that tepid water feels hot if the hand be cold, but cold if the hand be hot.

XIV.

How poor we are in history any one may see from the foregoing tables; where I not only insert sometimes mere traditions and reports (though never with-

out a note of doubtful credit and authority) in place of history proved and instances certain, but am also frequently forced to use the words "Let trial be made," or "Let it be further inquired."

XV.

The work and office of these three tables I call the Presentation of Instances to the Understanding. Which presentation having been made, Induction itself must be set at work; for the problem is, upon a review of the instances, all and each, to find such a nature as is always present or absent with the given nature, and always increases and decreases with it; and which is, as I have said, a particular case of a more general nature. Now if the mind attempt this affirmatively from the first, as when left to itself it is always wont to do, the result will be fancies and guesses and notions ill defined, and axioms that must be mended every day; unless like the schoolmen we have a mind to fight for what is false; though doubtless these will be better or worse according to the faculties and strength of the understanding which is at work. To God, truly, the Giver and Architect of Forms, and it may be to the angels and higher intelligences, it belongs to have an affirmative knowledge of forms immediately, and from the first contemplation. But this assuredly is more than man can do, to whom it is granted only to proceed at first by negatives, and at last to end in affirmatives, after exclusion has been exhausted.

XVI.

We must make therefore a complete solution and separation of nature, not indeed by fire, but by the mind, which is a kind of divine fire. The first work

therefore of true induction (as far as regards the discovery of Forms) is the rejection or exclusion of the several natures which are not found in some instance where the given nature is present, or are found in some instance where the given nature is absent, or are found to increase in some instance when the given nature decreases, or to decrease when the given nature increases. Then indeed after the rejection and exclusion has been duly made, there will remain at the bottom, all light opinions vanishing into smoke, a Form affirmative, solid and true and well defined. This is quickly said; but the way to come at it is winding and intricate. I will endeavour however not to overlook any of the points which may help us towards it.

XVII.

But when I assign so prominent a part to Forms, I cannot too often warn and admonish men against applying what I say to those forms to which their thoughts and contemplations have hitherto been accustomed.

For in the first place I do not at present speak of Compound Forms, which are, as I have remarked, combinations of simple natures according to the common course of the universe; as of the lion, eagle, rose, gold, and the like. It will be time to treat of these when we come to the Latent Processes and Latent Configurations, and the discovery of them, as they are found in what are called substances or natures concrete.

And even in the case of simple natures I would not be understood to speak of abstract forms and ideas, either not defined in matter at all, or ill defined. For

when I speak of Forms, I mean nothing more than those laws and determinations of absolute actuality, which govern and constitute any simple nature, as heat, light, weight, in every kind of matter and subject that is susceptible of them. Thus the Form of Heat or the Form of Light is the same thing as the Law of Heat or the Law of Light. Nor indeed do I ever allow myself to be drawn away from things themselves and the operative part. And therefore when I say (for instance) in the investigation of the form of heat, "reject rarity," or "rarity does not belong to the form of heat," it is the same as if I said, "It is possible to superinduce heat on a dense body;" or, "It is possible to take away or keep out heat from a rare body."

But if any one conceive that my Forms too are of a somewhat abstract nature, because they mix and combine things heterogeneous (for the heat of heavenly bodies and the heat of fire seem to be very heterogeneous; so do the fixed red of the rose or the like, and the apparent red in the rainbow, the opal, or the diamond; so again do the different kinds of death; death by drowning, by hanging, by stabbing, by apoplexy, by atrophy; and yet they agree severally in the nature of heat, redness, death); if any one, I say, be of this opinion, he may be assured that his mind is held in captivity by custom, by the gross appearance of things, and by men's opinions. For it is most certain that these things, however heterogeneous and alien from each other, agree in the Form or Law which governs heat, redness and death; and that the power of man cannot possibly be emancipated and freed from the common course of nature, and expanded and exalted to new efficients and new modes of operation, except by the

revelation and discovery of Forms of this kind. And yet, when I have spoken of this union of nature, which is the point of most importance, I shall proceed to the divisions and veins of nature, as well the ordinary as those that are more inward and exact, and speak of them in their place.

XVIII.

I must now give an example of the Exclusion or Rejection of natures which by the Tables of Presentation are found not to belong to the Form of Heat; observing in the meantime that not only each table suffices for the rejection of any nature, but even any one of the particular instances contained in any of the tables. For it is manifest from what has been said that any one contradictory instance overthrows a conjecture as to the Form. But nevertheless for clearness' sake and that the use of the tables may be more plainly shown, I sometimes double or multiply an exclusion.

An Example of Exclusion, or Rejection of Natures from the Form of Heat.

1. On account of the rays of the sun, reject the nature of the elements.

2. On account of common fire, and chiefly subterraneous fires (which are the most remote and most completely separate from the rays of heavenly bodies), reject the nature of heavenly bodies.

3. On account of the warmth acquired by all kinds of bodies (minerals, vegetables, skin of animals, water, oil, air, and the rest) by mere approach to a fire, or other hot body, reject the distinctive or more subtle texture of bodies.

4. On account of ignited iron and other metals, which communicate heat to other bodies and yet lose none of their weight or substance, reject the communication or admixture of the substance of another hot body.

5. On account of boiling water and air, and also on account of metals and other solids that receive heat but not to ignition or red heat, reject light or brightness.

6. On account of the rays of the moon and other heavenly bodies, with the exception of the sun, also reject light and brightness.

7. By a comparison of ignited iron and the flame of spirit of wine (of which ignited iron has more heat and less brightness, while the flame of spirit of wine has more brightness and less heat), also reject light and brightness.

8. On account of ignited gold and other metals, which are of the greatest density as a whole, reject rarity.

9. On account of air, which is found for the most part cold and yet remains rare, also reject rarity.

10. On account of ignited iron, which does not swell in bulk, but keeps within the same visible dimensions, reject local or expansive motion of the body as a whole.

11. On account of the dilation of air in calendar glasses and the like, wherein the air evidently moves locally and expansively and yet acquires no manifest increase of heat, also reject local or expansive motion of the body as a whole.

12. On account of the ease with which all bodies are heated, without any destruction or observable alteration, reject a destructive nature, or the violent communication of any new nature.

13. On account of the agreement and conformity of the similar effects which are wrought by heat and cold, reject motion of the body as a whole, whether expansive or contractive.

14. On account of heat being kindled by the attrition of bodies, reject a principial nature. By principial nature I mean that which exists in the nature of things positively, and not as the effect of any antecedent nature.

There are other natures beside these; for these tables are not perfect, but meant only for examples.

All and each of the above mentioned natures do *not* belong to the Form of Heat. And from all of them man is freed in his operations on Heat.

XIX.

In the process of Exclusion are laid the foundations of true Induction, which however is not completed till it arrives at an Affirmative. Nor is the Exclusive part itself at all complete, nor indeed can it possibly be so at first. For Exclusion is evidently the rejection of simple natures; and if we do not yet possess sound and true notions of simple natures, how can the process of Exclusion be made accurate? Now some of the above-mentioned notions (as that of the nature of the elements, of the nature of heavenly bodies, of rarity) are vague and ill-defined. I therefore, well knowing and nowise forgetting how great a work I am about (viz. that of rendering the human understanding a match for things and nature), do not rest satisfied with the precepts I have laid down; but proceed further to devise and supply more powerful aids for the use of

the understanding; which I shall now subjoin. And assuredly in the Interpretation of Nature the mind should by all means be so prepared and disposed, that while it rests and finds footing in due stages and degrees of certainty, it may remember withal (especially at the beginning) that what it has before it depends in great measure upon what remains behind.

XX.

And yet since truth will sooner come out from error than from confusion, I think it expedient that the understanding should have permission, after the three Tables of First Presentation (such as I have exhibited) have been made and weighed, to make an essay of the Interpretation of Nature in the affirmative way; on the strength both of the instances given in the tables, and of any others it may meet with elsewhere. Which kind of essay I call the *Indulgence of the Understanding*, or the *Commencement of Interpretation*, or the *First Vintage*.

First Vintage concerning the Form of Heat.

It is to be observed that the Form of a thing is to be found (as plainly appears from what has been said) in each and all the instances, in which the thing itself is to be found; otherwise it would not be the Form. It follows therefore that there can be no contradictory instance. At the same time the Form is found much more conspicuous and evident in some instances than in others; namely in those wherein the nature of the Form is less restrained and obstructed and kept within bounds by other natures. Instances of this kind I call Shining or Striking Instances. Let us now therefore

proceed to the First Vintage concerning the Form of Heat.

From a survey of the instances, all and each, the nature of which Heat is a particular case appears to be Motion. This is displayed most conspicuously in flame, which is always in motion, and in boiling or simmering liquids, which also are in perpetual motion. It is also shown in the excitement or increase of heat caused by motion, as in bellows and blasts; on which see Tab. 3. Inst. 29.; and again in other kinds of motion, on which see Tab. 3. Inst. 28. and 31. Again it is shown in the extinction of fire and heat by any strong compression, which checks and stops the motion; on which see Tab. 3. Inst. 30. and 32. It is shown also by this, that all bodies are destroyed, or at any rate notably altered, by all strong and vehement fire and heat; whence it is quite clear that heat causes a tumult and confusion and violent motion in the internal parts of a body, which perceptibly tends to its dissolution.

When I say of Motion that it is as the genus of which heat is a species, I would be understood to mean, not that heat generates motion or that motion generates heat (though both are true in certain cases), but that Heat itself, its essence and quiddity, is Motion and nothing else; limited however by the specific differences which I will presently subjoin, as soon as I have added a few cautions for the sake of avoiding ambiguity.

Sensible heat is a relative notion, and has relation to

man, not to the universe; and is correctly defined as merely the effect of heat on the animal spirits. Moreover, in itself it is variable, since the same body, according as the senses are predisposed, induces a perception of cold as well as of heat. This is clear from Inst. 41. Tab. 3.

Nor again must the communication of Heat, or its transitive nature, by means of which a body becomes hot when a hot body is applied to it, be confounded with the Form of Heat. For heat is one thing, heating another. Heat is produced by the motion of attrition without any preceding heat, an instance which excludes heating from the Form of Heat. And even when heat is produced by the approach of a hot body, this does not proceed from the Form of Heat, but depends entirely on a higher and more general nature, viz. on the nature of assimilation or self-multiplication, a subject which requires a separate inquiry.

Again, our notion of fire is popular, and of no use; being made up of the combination in any body of heat and brightness, as in common flame and bodies heated to redness.

Having thus removed all ambiguity, I come at length to the true specific differences which limit Motion and constitute it the Form of Heat.

> The first difference then is this. Heat is an expansive motion, whereby a body strives to dilate and stretch itself to a larger sphere or dimension than it had previously occupied. This difference is most observable in flame, where the smoke or thick vapour manifestly dilates and expands itself into flame.

It is shown also in all boiling liquid, which manifestly swells, rises, and bubbles; and carries on the process of self-expansion, till it turns into a body far more extended and dilated than the liquid itself, namely, into vapour, smoke, or air.

It appears likewise in all wood and combustibles, from which there generally arises exudation and always evaporation.

It is shown also in the melting of metals, which, being of the compactest texture, do not readily swell and dilate; but yet their spirit being dilated in itself, and thereupon conceiving an appetite for further dilation, forces and agitates the grosser parts into a liquid state. And if the heat be greatly increased it dissolves and turns much of their substance to a volatile state.

It is shown also in iron or stones, which, though not melted or dissolved, are yet softened. This is the case also with sticks, which when slightly heated in hot ashes become flexible.

But this kind of motion is best seen in air, which continuously and manifestly dilates with a slight heat, as appears in Inst. 38. Tab. 3.

It is shown also in the opposite nature of cold. For cold contracts all bodies and makes them shrink; insomuch that in intense frosts nails fall out from walls, brazen vessels crack, and heated glass on being suddenly placed in the cold cracks and breaks. In like manner air is contracted by a slight chill, as in Inst. 38. Tab. 3. But on these points I shall speak more at length in the inquiry concerning Cold.

Nor is it surprising that heat and cold should

exhibit many actions in common (for which see Inst. 32. Tab. 2.), when we find two of the following specific differences (of which I shall speak presently) suiting either nature; though in this specific difference (of which I am now speaking) their actions are diametrically opposite. For heat gives an expansive and dilating, cold a contractive and condensing motion.

The second difference is a modification of the former; namely, that heat is a motion expansive or towards the circumference, but with this condition, that the body has at the same time a motion upwards. For there is no doubt that there are many mixed motions. For instance, an arrow or dart turns as it goes forward, and goes forward as it turns. And in like manner the motion of heat is at once a motion of expansion and a motion upwards. This difference is shown by putting a pair of tongs or a poker in the fire. If you put it in perpendicularly and hold it by the top, it soon burns your hand; if at the side or from below, not nearly so soon.

It is also observable in distillations *per descensorium;* which men use for delicate flowers, that soon lose their scent. For human industry has discovered the plan of placing the fire not below but above, that it may burn the less. For not only flame tends upwards, but also all heat.

But let trial be made of this in the opposite nature of cold; viz. whether cold does not contract a body downwards, as heat dilates a body upwards. Take therefore two iron rods, or two

glass tubes, exactly alike; warm them a little, and place a sponge steeped in cold water or snow at the bottom of the one, and the same at the top of the other. For I think that the extremities of the rod which has the snow at the top will cool sooner than the extremities of the other which has the snow at the bottom; just as the opposite is the case with heat.

The third specific difference is this; that heat is a motion of expansion, not uniformly of the whole body together, but in the smaller parts of it; and at the same time checked, repelled, and beaten back, so that the body acquires a motion alternative, perpetually quivering, striving and struggling, and irritated by repercussion, whence springs the fury of fire and heat.

This specific difference is most displayed in flame and boiling liquids, which are perpetually quivering and swelling in small portions, and again subsiding.

It is also shown in those bodies which are so compact that when heated or ignited they do not swell or expand in bulk; as ignited iron, in which the heat is very sharp.

It is shown also in this, that a fire burns most briskly in the coldest weather.

Again, it is shown in this, that when the air is extended in a calendar glass without impediment or repulsion, — that is to say, uniformly and equably, — there is no perceptible heat. Also when wind escapes from confinement, although it burst forth with the greatest violence, there is no very great heat perceptible; because the motion

is of the whole, without a motion alternating in the particles. And with a view to this, let trial be made whether flame does not burn more sharply towards the sides than in the middle of the flame.

It is also shown in this, that all burning acts on minute pores of the body burnt; so that burning undermines, penetrates, pricks, and stings the body like the points of an infinite number of needles. It is also an effect of this, that all strong waters (if suited to the body on which they are acting) act as fire does, in consequence of their corroding and pungent nature.

And this specific difference (of which I am now speaking) is common also to the nature of cold; for in cold the contractive motion is checked by a resisting tendency to expand, just as in heat the expansive motion is checked by a resisting tendency to contract. Thus, whether the particles of a body work inward or outward, the mode of action is the same, though the degree of strength be very different; because we have not here on the surface of the earth anything that is intensely cold. See Inst. 27. Tab. 9.

The fourth specific difference is a modification of the last; it is, that the preceding motion of stimulation or penetration must be somewhat rapid and not sluggish, and must proceed by particles, minute indeed, yet not the finest of all, but a degree larger.

This difference is shown by a comparison of the effects of fire with the effects of time or age. Age or time dries, consumes, undermines and reduces

to ashes, no less than fire; indeed with an action far more subtle; but because such motion is very sluggish, and acts on particles very small, the heat is not perceived.

It is also shown by comparing the dissolution of iron and gold. Gold is dissolved without any heat being excited, while the dissolution of iron is accompanied by a violent heat, though it takes place in about the same time. The reason is that in gold the separating acid enters gently and works with subtlety, and the parts of the gold yield easily; whereas in iron the entrance is rough and with conflict, and the parts of the iron have greater obstinacy.

It is shown also to some degree in some gangrenes and mortifications, which do not excite great heat or pain on account of the subtle nature of putrefaction.

Let this then be the First Vintage or Commencement of Interpretation concerning the Form of Heat, made by way of indulgence to the understanding.

Now from this our First Vintage it follows that the Form or true definition of heat (heat, that is, in relation to the universe, not simply in relation to man) is in few words as follows: *Heat is a motion, expansive, restrained, and acting in its strife upon the smaller particles of bodies.* But the expansion is thus modified; *while it expands all ways, it has at the same time an inclination upwards.* And the struggle in the particles is modified also; *it is not sluggish, but hurried and with violence.*

Viewed with reference to operation it is the same thing. For the direction is this: *If in any natural body*

you can excite a dilating or expanding motion, and can so repress this motion and turn it back upon itself, that the dilation shall not proceed equably, but have its way in one part and be counteracted in another, you will undoubtedly generate heat; without taking into account whether the body be elementary (as it is called) or subject to celestial influence; whether it be luminous or opaque; rare or dense; locally expanded or confined within the bounds of its first dimension; verging to dissolution or remaining in its original state; animal, vegetable, or mineral, water, oil or air, or any other substance whatever susceptible of the above-mentioned motion. Sensible heat is the same thing; only it must be considered with reference to the sense. Let us now proceed to further aids.

XXI.

The Tables of First Presentation and the Rejection or process of Exclusion being completed, and also the First Vintage being made thereupon, we are to proceed to the other helps of the understanding in the Interpretation of Nature and true and perfect Induction. In propounding which, I mean, when Tables are necessary, to proceed upon the Instances of Heat and Cold; but when a smaller number of examples will suffice, I shall proceed at large; so that the inquiry may be kept clear, and yet more room be left for the exposition of the system.

I propose to treat then in the first place of *Prerogative Instances;* secondly, of the *Supports of Induction;* thirdly, of the *Rectification of Induction;* fourthly, of *Varying the Investigation according to the nature of the Subject;* fifthly, of *Prerogative Natures* with respect to Investigation, or of what should be inquired first and

what last; sixthly, of the *Limits of Investigation*, or a Synopsis of all Natures in the Universe; seventhly, of the *Application to Practice*, or of things in their relation to Man; eighthly, of *Preparations for Investigation;* and lastly, of the *Ascending and Descending Scale of Axioms.*

XXII.

Among Prerogative Instances I will place first *Solitary Instances.* Those are Solitary Instances which exhibit the nature under investigation in subjects which have nothing in common with other subjects except that nature; or, again, which do not exhibit the nature under investigation in subjects which resemble other subjects in every respect except in not having that nature. For it is clear that such instances make the way short, and accelerate and strengthen the process of exclusion; so that a few of them are as good as many.

For instance, if we are inquiring into the nature of Colour, prisms, crystals, which show colours not only in themselves but externally on a wall, dews, &c., are Solitary Instances. For they have nothing in common with the colours fixed in flowers, coloured stones, metals, woods, &c., except the colour. From which we easily gather that colour is nothing more than a modification of the image of light received upon the object, resulting in the former case from the different degrees of incidence, in the latter from the various textures and configurations of the body. These instances are Solitary in respect of resemblance.

Again, in the same investigation, the distinct veins of white and black in marble, and the variegation of colour in flowers of the same species, are Solitary Instances. For the black and white streaks in marble,

or the spots of pink and white in a pink, agree in everything almost except the colour. From which we easily gather that colour has little to do with the intrinsic nature of a body, but simply depends on the coarser and as it were mechanical arrangement of the parts. These instances are Solitary in respect of difference. Both kinds I call *Solitary Instances*, or *Ferine*, to borrow a term from astronomers.

XXIII.

Among Prerogative Instances I will next place *Migratory Instances*. They are those in which the nature in question is in the process of being produced when it did not previously exist, or on the other hand of disappearing when it existed before. And therefore, in either transition, such instances are always twofold, or rather it is one instance in motion or passage, continued till it reaches the opposite state. Such instances not only accelerate and strengthen the exclusive process, but also drive the affirmative or Form itself into a narrow compass. For the Form of a thing must necessarily be something which in the course of this migration is communicated, or on the other hand which in the course of this migration is removed and destroyed. And though every exclusion promotes the affirmative, yet this is done more decidedly when it occurs in the same than in different subjects. And the betrayal of the form in a single instance leads the way (as is evident from all that has been said) to the discovery of it in all. And the simpler the Migration, the more must the instance be valued. Besides Migratory Instances are of great use with a view to operation; because in exhibiting the form in connexion with

that which causes it to be or not to be, they supply a clear direction for practice in some cases; whence the passage is easy to the cases that lie next. There is however in these instances a danger which requires caution; viz. lest they lead us to connect the Form too much with the efficient, and so possess the understanding, or at least touch it, with a false opinion concerning the Form, drawn from a view of the efficient. But the efficient is always understood to be merely the vehicle that carries the Form. This is a danger however easily remedied by the process of exclusion legitimately conducted.

I must now give an example of a Migratory Instance. Let the nature to be investigated be Whiteness; an instance migrating to production or existence is glass whole and pounded. Again, simple water and water agitated into froth. For glass and water in their simple state are transparent, not white; whereas pounded glass and water in froth are white, not transparent. We must therefore inquire what has happened to the glass or water from this Migration. For it is obvious that the Form of Whiteness is communicated and conveyed by that pounding of the glass and that agitation of the water. We find, however, that nothing has been added except the breaking up of the glass and water into small parts, and the introduction of air. But we have made no slight advance to the discovery of the Form of Whiteness when we know that two bodies, both transparent but in a greater or less degree (viz. air and water, or air and glass), do when mingled in small portions together exhibit whiteness, through the unequal refraction of the rays of light.

But an example must at the same time be given of

the danger and caution to which I alluded. For at this point it might readily suggest itself to an understanding led astray by efficient causes of this kind, that air is always required for the Form of Whiteness, or that Whiteness is generated by transparent bodies only; notions entirely false, and refuted by numerous exclusions. Whereas it will be found that (setting air and the like aside) bodies entirely even in the particles which affect vision are transparent, bodies simply uneven are white; bodies uneven and in a compound yet regular texture are all colours except black; while bodies uneven and in a compound, irregular, and confused texture are black. Here then I have given an example of an Instance Migrating to production or existence in the proposed nature of Whiteness. An Instance Migrating to destruction in the same nature of Whiteness, is froth or snow in dissolution. For the water puts off Whiteness and puts on transparency, on returning to its integral state without air.

Nor must I by any means omit to mention that under Migratory Instances are to be included not only those which are passing towards production and destruction, but also those which are passing towards increase and decrease; since these also help to discover the Form, as is clear from the above definition of Form and the Table of Degrees. Thus paper, which is white when dry, but when wetted (that is, when air is excluded and water introduced) is less white and approaches nearer to the transparent, is analogous to the above given Instances.

XXIV.

Among Prerogative Instances I will put in the third place *Striking Instances*, of which I have made men-

tion in the First Vintage concerning Heat, and which I also call *Shining Instances*, or *Instances Freed and Predominant.* They are those which exhibit the nature in question naked and standing by itself, and also in its exaltation or highest degree of power; as being disenthralled and freed from all impediments, or at any rate by virtue of its strength dominant over, suppressing and coercing them. For since every body contains in itself many forms of natures united together in a concrete state, the result is that they severally crush, depress, break, and enthrall one another, and thus the individual forms are obscured. But certain subjects are found wherein the required nature appears more in its vigour than in others, either through the absence of impediments or the predominance of its own virtue. And instances of this kind strikingly display the Form. At the same time in these instances also we must use caution, and check the hurry of the understanding. For whatever displays the Form too conspicuously, and seems to force it on the notice of the understanding, should be held suspect, and recourse be had to a rigid and careful exclusion.

To take an example; let the nature inquired into be Heat. A Striking Instance of the motion of expansion, which (as stated above) is the main element in the Form of Heat, is a calendar glass of air. For flame, though it manifestly exhibits expansion, still, as susceptible of momentary extinction, does not display the progress of expansion. Boiling water too, on account of the easy transition of water to vapour or air, does not so well exhibit the expansion of water in its own body. Again, ignited iron and like bodies are so far from displaying the progress of expansion, that in

consequence of their spirit being crushed and broken by the coarse and compact particles which curb and subdue it, the expansion itself is not at all conspicuous to the senses. But a calendar glass strikingly displays expansion in air, at once conspicuous, progressive, permanent, and without transition.

To take another example; let the nature inquired into be Weight. A Striking Instance of weight is quicksilver. For it far surpasses in weight all substances but gold, and gold itself is not much heavier. But quicksilver is a better instance for indicating the Form of Weight than gold; because gold is solid and consistent, characteristics which seem related to density; whereas quicksilver is liquid and teeming with spirit, and yet is heavier by many degrees than the diamond and other bodies that are esteemed the most solid. From which it is obvious that the Form of Heaviness or Weight depends simply on quantity of matter and not on compactness of frame.

XXV.

Among Prerogative Instances I will put in the fourth place *Clandestine Instances*, which I also call *Instances of the Twilight*, and which are pretty nearly the opposites of Striking Instances. For they exhibit the nature under investigation in its lowest degree of power, and as it were in its cradle and rudiments; striving indeed and making a sort of first attempts, but buried under and subdued by a contrary nature. Such instances however are of very great service for the discovery of Forms; because as Striking Instances lead easily to specific differences, so are Clandestine Instances the best guides to *genera*, that is, to those com-

mon natures, whereof the natures proposed are nothing more than particular cases.

For example, let the nature proposed be Consistency, or the nature of that which determines its own figure; opposed to which is Fluidity. Those are Clandestine Instances which exhibit some feeble and low degree of consistency in a fluid; as a bubble of water, which is a sort of consistent pellicle of determined figure, made of the body of the water. Of a similar kind are the droppings from a house, which if there be water to follow, lengthen themselves out into a very thin thread, to preserve the continuity of the water; but if there be not water enough to follow, then they fall in round drops, which is the figure that best preserves the water from a solution of continuity. But at the very moment of time when the thread of water ceases and the descent in drops begins, the water itself recoils upwards to avoid discontinuation. Again in metals, which in fusion are liquid but more tenacious, the molten drops often fly to the top and stick there. A somewhat similar instance is that of children's looking-glasses, which little boys make on rushes with spittle; where also there is seen a consistent pellicle of water. This however is much better shown in that other childish sport, when they take water, made a little more tenacious by soap, and blow it through a hollow reed, and so shape the water into a sort of castle of bubbles; which by the interposition of the air become so consistent as to admit of being thrown some distance without discontinuation. But best of all is it seen in frost and snow, which assume such a consistency that they can be almost cut with a knife, although they are formed out of air and water, both fluids. All which facts not ob-

scurely intimate that Consistent and Fluid are only vulgar notions, and relative to the sense; and that in fact there is inherent in all bodies a disposition to shun and escape discontinuation; but that it is faint and feeble in homogeneous bodies (as fluids), more lively and strong in bodies compounded of heterogeneous matter; the reason being that the approach of heterogeneous matter binds bodies together, while the insinuation of homogeneous matter dissolves and relaxes them.

To take another instance, let the proposed nature be the attraction or coming together of bodies. In the investigation of its Form the most remarkable Striking Instance is the magnet. But there is a contrary nature to the attractive; namely, the non-attractive, which exists in a similar substance. Thus there is iron which does not attract iron, just as lead does not attract lead, nor wood wood, nor water water. Now a Clandestine Instance is a magnet armed with iron, or rather the iron in an armed magnet. For it is a fact in nature that an armed magnet at some distance off does not attract iron more powerfully than an unarmed magnet. But if the iron be brought so near as to touch the iron in the armed magnet, then the armed magnet supports a far greater weight of iron than a simple and unarmed magnet; on account of the similarity of substance between the pieces of iron; an operation altogether clandestine and latent in the iron before the magnet was applied. Hence it is manifest that the Form of Coition is something which is lively and strong in the magnet, feeble and latent in iron. Again, it has been observed that small wooden arrows without an iron point, discharged from large engines,

pierce deeper into wooden material (say the sides of ships, or the like) than the same arrows tipped with iron, on account of the similarity of substance between the two pieces of wood; although this property had previously been latent in the wood. In like manner, although air does not manifestly attract air or water water in entire bodies, yet a bubble is more easily dissolved on the approach of another bubble than if that other bubble were away, by reason of the appetite of coition between water and water, and between air and air. Such Clandestine Instances (which, as I have said, are of the most signal use) exhibit themselves most conspicuously in small and subtle portions of bodies; the reason being that larger masses follow more general forms; as shall be shown in the proper place.

XXVI.

Among Prerogative Instances I will put in the fifth place *Constitutive Instances*, which I also call *Manipular*. They are those which constitute a single species of the proposed nature a sort of Lesser Form. For since the genuine Forms (which are always convertible with the proposed natures) lie deep and are hard to find, it is required by the circumstances of the case and the infirmity of the human understanding that particular Forms, which collect together certain groups of instances (though not all) into some common notion, be not neglected, but rather be diligently observed. For whatever unites nature, though imperfectly, paves the way to the discovery of Forms. Instances therefore which are useful in this regard are of no despicable power, but have a certain prerogative.

But great caution must here be employed, lest the human understanding, after having discovered many of those particular Forms and thereupon established partitions or divisions of the nature in question, be content to rest therein, and instead of proceeding to the legitimate discovery of the great Form, take it for granted that the nature from its very roots is manifold and divided, and so reject and put aside any further union of the nature, as a thing of superfluous subtlety and verging on mere abstraction.

For example, let the proposed nature be Memory, or that which excites and aids the memory. Constitutive Instances are, order or distribution, which clearly aids the memory; also topics or "places" in artificial memory; which may either be *places* in the proper sense of the word, as a door, angle, window, and the like; or familiar and known persons; or any other things at pleasure (provided they be placed in a certain order), as animals, vegetables; words too, letters, characters, historical persons, and the like; although some of these are more suitable and convenient than others. Such artificial places help the memory wonderfully, and exalt it far above its natural powers. Again, verse is learnt and remembered more easily than prose. From this group of three instances, viz. order, artificial places, and verse, one species of aid to the memory is constituted. And this species may with propriety be called the cutting off of infinity. For when we try to recollect or call a thing to mind, if we have no prenotion or perception of what we are seeking, we seek and toil and wander here and there, as if in infinite space. Whereas if we have any sure prenotion, infinity is at once cut off, and the

memory has not so far to range. Now in the three foregoing instances the prenotion is clear and certain. In the first it must be something which suits the order; in the second it must be an image which bears some relation or conformity to the places fixed; in the third, it must be words that fall into the verse; and thus infinity is cut off. Other instances, again, will give us this second species; that whatever brings the intellectual conception into contact with the sense (which is indeed the method most used in mnemonics) assists the memory. Other instances will give us this third species; that things which make their impression by way of a strong affection, as by inspiring fear, admiration, shame, delight, assist the memory. Other instances will give us this fourth species; that things which are chiefly imprinted when the mind is clear and not occupied with anything else either before or after, as what is learnt in childhood, or what we think of before going to sleep, also things that happen for the first time, dwell longest in the memory. Other instances will give us this fifth species; that a multitude of circumstances or points to take hold of aids the memory; as writing with breaks and divisions, reading or reciting aloud. Lastly, other instances will give us this sixth species; that things which are waited for and raise the attention dwell longer in the memory than what flies quickly by. Thus, if you read anything over twenty times, you will not learn it by heart so easily as if you were to read it only ten, trying to repeat it between whiles, and when memory failed looking at the book. It appears then that there are six Lesser Forms of aids to the memory; viz. the cutting off of infinity; the reduction of the intellectual to the

sensible; impression made on the mind in a state of strong emotion; impression made on the mind disengaged; multitude of points to take hold of; expectation beforehand.

To take another example, let the proposed nature be Taste or Tasting. The following instances are Constitutive. Persons who are by nature without the sense of smell cannot perceive or distinguish by taste food that is rancid or putrid, nor food that is seasoned with garlic, or with roses, or the like. Again, persons whose nostrils are accidentally obstructed by a catarrh cannot distinguish or perceive anything putrid or rancid or sprinkled with rosewater. Again, persons thus affected with catarrh, if while they have something fetid or perfumed in their mouth or palate they blow their nose violently, immediately perceive the rancidity or the perfume. These instances then will give and constitute this species, or rather division, of taste; that the sense of taste is in part nothing else than an internal smell, passing and descending from the upper passages of the nose to the mouth and palate. On the other hand the tastes of salt, sweet, sour, acid, rough, bitter, and the like, are as perceptible to those in whom the sense of smell is wanting or stopped as to any one else; so that it is clear that the sense of taste is a sort of compound of an internal smell and a delicate power of touch; of which this is not the place to speak.

To take another example, let the proposed nature be the communication of quality without admixture of substance. The instance of light will give or constitute one species of communication; heat and the magnet another. For the communication of light is momentaneous, and ceases at once on the removal of the

original light. But heat and the virtue of the magnet, after they have been transmitted to or rather excited in a body, lodge and remain there for a considerable time after the removal of the source of motion.

Very great in short is the prerogative of Constitutive Instances; for they are of much use in the forming of definitions (especially particular definitions) and in the division and partition of natures; with regard to which it was not ill said by Plato, "That he is to be held as a god who knows well how to define and to divide."

XXVII.

Among Prerogative Instances I will put in the sixth place *Instances Conformable*, or *of Analogy;* which I also call *Parallels*, or *Physical Resemblances*. They are those which represent the resemblances and conjugations of things, not in Lesser Forms (as Constitutive Instances do) but merely in the concrete. Hence they may be called the first and lowest steps toward the union of nature. Nor do they constitute any axiom immediately from the beginning, but simply point out and mark a certain agreement in bodies. But although they are of little use for the discovery of forms, they nevertheless are very serviceable in revealing the fabric of the parts of the universe, and anatomising its members; from which they often lead us along to sublime and noble axioms, especially those which relate to the configuration of the world rather than to simple forms and natures.

For example, these following are instances of Conformity; a looking-glass and the eye; and again, the construction of the ear and places returning an echo. From which conformity, to say nothing of the mere

observation of the resemblance which is in many respects useful, it is easy to gather and form this axiom, — that the organs of the senses, and bodies which produce reflexions to the senses, are of a like nature. Again, upon this hint the understanding easily rises to a higher and nobler axiom, which is this: that there is no difference between the consents or sympathies of bodies endowed with sensation and those of inanimate bodies without sensation, except that in the former an animal spirit is added to the body so disposed, but is wanting in the latter. Whence it follows that there might be as many senses in animals as there are sympathies between inanimate bodies, if there were perforations in the animate body, allowing the animal spirit to pass freely into a member rightly disposed, as into a fit organ. Again, as many as are the senses in animals, so many without doubt are the motions in an inanimate body where animal spirit is wanting; though necessarily there are many more motions in inanimate bodies than there are senses in animate, on account of the paucity of organs of sense. And of this a manifest example is exhibited in pain. For though there are many kinds and varieties of pain in animals (as the pain of burning, for one, of intense cold for another; again, of pricking, squeezing, stretching, and the like), it is yet most certain that all of them, as far as the motion is concerned, exist in inanimate substances; for example, in wood or stone, when it is burnt or frozen or pricked or cut or bent or stretched, and so on; though they do not enter the senses for want of the animal spirit.

Again, the roots and branches of plants (which may seem strange) are Conformable Instances. For all veg-

etable matter swells and pushes out its parts to the surface, as well upwards as downwards. Nor is there any other difference between roots and branches than that the root is buried in the ground, while the branches are exposed to the air and sun. For if you take a tender and flourishing branch of a tree, and bend it down into a clod of earth, although it does not cohere with the ground itself, it presently produces not a branch but a root. And *vice versâ*, if earth be placed at the top, and so kept down with a stone or any hard substance as to check the plant and prevent it from shooting upwards, it will put forth branches into the air downwards.

Again, the gums of trees, and most rock gems, are Conformable Instances. For both of these are nothing else than exudations and filterings of juices; the former from trees, the latter from rocks: whence is produced the splendour and clearness in each; that is, by the fine and delicate filtering. Hence too it is that the hairs of animals are not generally so beautiful and of so vivid a colour as the feathers of birds; viz. because the juices do not filter so finely through skin as through quills.

Again, the scrotum in males and the matrix in females are Conformable Instances. So that the great organic difference between the sexes (in land animals at least) appears to be nothing more than that the one organisation is external, and the other internal. That is to say, the greater force of heat in the male thrusts the genitals outwards; whereas in the female the heat is too feeble to effect this, and thus they are contained within.

The fins of fish again and the feet of quadrupeds, or

the feet and wings of birds, are Conformable Instances; to which Aristotle has added the four folds in the motions of serpents. Whence it appears that in the structure of the universe the motions of living creatures are generally effected by a quaternion of limbs or of bendings.

Again, the teeth of land animals and the beaks of birds are Conformable Instances; from which it is manifest that in all perfect animals there is a determination of some hard substance to the mouth.

Nor is that an absurd similitude or conformity which has been remarked between man and a plant inverted. For the root of the nerves and faculties in animals is the head, while the seminal parts are the lowest, — the extremities of the legs and arms not reckoned. In a plant on the other hand, the root (which answers to the head) is regularly placed in the lowest part, and the seeds in the highest.

To conclude, it cannot too often be recommended and enjoined, that men's diligence in investigating and amassing natural history be henceforward entirely changed, and turned into the direction opposite to that now in use. For hitherto men have used great and indeed over-curious diligence in observing the variety of things, and explaining the exact specific differences of animals, herbs, and fossils; most of which are rather sports of nature than of any serious use towards science. Such things indeed serve to delight, and sometimes even give help in practice; but for getting insight into nature they are of little service or none. Men's labour therefore should be turned to the investigation and observation of the resemblances and analogies of things, as well in wholes as in parts. For these it

is that detect the unity of nature, and lay a foundation for the constitution of sciences.

But here must be added a strict and earnest caution, that those only are to be taken for Conformable and Analogous Instances which indicate (as I said at the beginning) Physical Resemblances; that is, real and substantial resemblances; resemblances grounded in nature, not accidental or merely apparent; much less superstitious or curious resemblances, such as the writers on natural magic (very frivolous persons, hardly to be named in connexion with such serious matters as we are now about) are everywhere parading; similitudes and sympathies of things that have no reality, which they describe and sometimes invent with great vanity and folly.

But to leave these; the very configuration of the world itself in its greater parts presents Conformable Instances which are not to be neglected. Take for example Africa and the region of Peru with the continent stretching to the Straits of Magellan, in each of which tracts there are similar isthmuses and similar promontories; which can hardly be by accident.

Again, there is the Old and New World; both of which are broad and extended towards the north, narrow and pointed towards the south.

We have also most remarkable Instances of Conformity in the intense cold existing in what is called the middle region of the air and the violent fires which are often found bursting forth from beneath the ground; which two things are *ultimities* and extremes; that is to say, the extreme of the nature of cold towards the circumference of the sky, of heat towards the bowels of the earth; by *antiperistasis* or the rejection of the contrary nature.

Lastly, the Conformity of Instances in the axioms of science is deserving of notice. Thus the rhetorical trope of deceiving expectation is conformable with the musical trope of avoiding or sliding from the close or cadence: the mathematical postulate that if two things are equal to the same thing they are equal to one another, is conformable with the rule of the syllogism in logic which unites propositions agreeing in a middle term. In fine, a certain sagacity in investigating and hunting out Physical Conformities and Similitudes is of very great use in very many cases.

XXVIII.

Among Prerogative Instances I will put in the seventh place *Singular Instances;* which I also call *Irregular* or *Heteroclite;* to borrow a term from grammarians. They are such as exhibit bodies in the concrete, which seem to be out of the course and broken off from the order of nature, and not agreeing with other bodies of the same kind. For Conformable Instances are like each other; Singular Instances are like themselves alone. The use of Singular Instances is the same as that of Clandestine; namely to raise and unite nature for the purpose of discovering kinds or common natures, to be afterwards limited by true specific differences. For we are not to give up the investigation, until the properties and qualities found in such things as may be taken for miracles of nature be reduced and comprehended under some Form or fixed Law; so that all the irregularity or singularity shall be found to depend on some common Form, and the miracle shall turn out to be only in the exact specific differences, and the degree, and the rare concurrence; not in the

species itself; whereas now the thoughts of men go no further than to pronounce such things the secrets and mighty works of nature, things as it were causeless, and exceptions to general rules.

Examples of Singular Instances are the sun and moon among stars; the magnet among stones; quicksilver among metals; the elephant among quadrupeds; the venereal sense among kinds of touch; the scent of hounds among kinds of smell. So among grammarians the letter S is held singular, on account of its easy combination with consonants, sometimes with two, sometimes even with three; which property no other letter has. Such instances must be regarded as most valuable, because they sharpen and quicken investigation, and help to cure the understanding depraved by custom and the common course of things.

XXIX.

Among Prerogative Instances I will put in the eighth place *Deviating Instances;* that is, errors, vagaries and prodigies of nature, wherein nature deviates and turns aside from her ordinary course. Errors of nature differ from Singular Instances in this, that the latter are prodigies of species, the former of individuals. Their use is pretty nearly the same; for they correct the erroneous impressions suggested to the understanding by ordinary phenomena, and reveal Common Forms. For in these also we are not to desist from inquiry, until the cause of the deviation is discovered. This cause however does not rise properly to any Form, but simply to the latent process that leads to the Form. For he that knows the ways of nature will more easily observe her deviations; and on

the other hand he that knows her deviations will more accurately describe her ways.

They differ in this also from Singular Instances, that they give much more help to practice and the operative part. For to produce new species would be very difficult; but to vary known species, and thereby produce many rare and unusual results is less difficult. Now it is an easy passage from miracles of nature to miracles of art. For if nature be once detected in her deviation, and the reason thereof made evident, there will be little difficulty in leading her back by art to the point whither she strayed by accident; and that not only in one case, but also in others; for errors on one side point out and open the way to errors and deflexions on all sides. Under this head there is no need of examples; they are so plentiful. For we have to make a collection or particular natural history of all prodigies and monstrous births of nature; of everything in short that is in nature new, rare, and unusual. This must be done however with the strictest scrutiny, that fidelity may be ensured. Now those things are to be chiefly suspected, which depend in any way on religion; as the prodigies of Livy; and those not less which are found in writers on natural magic or alchemy, and men of that sort; who are a kind of suitors and lovers of fables. But whatever is admitted must be drawn from grave and credible history and trustworthy reports.

XXX.

Among Prerogative Instances I will put in the ninth place *Bordering Instances;* which I also call *Participles.* They are those which exhibit species of bodies that seem to be composed of two species, or to be rudiments

between one species and another. These instances might with propriety be reckoned among Singular or Heteroclite Instances; for in the whole extent of nature they are of rare and extraordinary occurrence. But nevertheless for their worth's sake they should be ranked and treated separately; for they are of excellent use in indicating the composition and structure of things, and suggesting the causes of the number and quality of the ordinary species in the universe, and carrying on the understanding from that which is to that which may be.

Examples of these are, moss, which holds a place between putrescence and a plant; some comets, between stars and fiery meteors; flying fish, between birds and fish; bats, between birds and quadrupeds: also the ape, between man and beast, —

"Simia quam similis turpissima bestia nobis;"

likewise the biformed births of animals, mixed of different species, and the like.

XXXI.

Among Prerogative Instances I will put in the tenth place *Instances of Power*, or of the *Fasces* (to borrow a term from the badges of empire); which I also call *Instances of the Wit*, or *Hands of Man*. These are the noblest and most consummate works in each art, exhibiting the ultimate perfection of it. For since our main object is to make nature serve the business and conveniences of man, it is altogether agreeable to that object that the works which are already in man's power should (like so many provinces formerly occupied and subdued) be noted and enumerated, especially such as

are the most complete and perfect; because starting from them we shall find an easier and nearer passage to new works hitherto unattempted. For if from an attentive contemplation of these a man pushes on his work with zeal and activity, he will infallibly either advance them a little further, or turn them aside to something in their neighbourhood, or even apply and transfer them to some more noble use.

Nor is this all. But as by rare and extraordinary works of nature the understanding is excited and raised to the investigation and discovery of Forms capable of including them; so also is this done by excellent and wonderful works of art; and that in a much greater degree, because the method of creating and constructing such miracles of art is in most cases plain, whereas in the miracles of nature it is generally obscure. But with these also we must use the utmost caution, lest they depress the understanding and fasten it as it were to the ground.

For there is danger lest the contemplation of such works of art, which appear to be the very summits and crowning points of human industry, may so astonish and bind and bewitch the understanding with regard to them, that it shall be incapable of dealing with any other, but shall think that nothing can be done in that kind except by the same way in which these were done; only with the use of greater diligence and more accurate preparation.

Whereas on the contrary this is certain; that the ways and means of achieving the effects and works hitherto discovered and observed are for the most part very poor things; and that all power of a high order depends on Forms, and is derived in order from the

sources thereof; not one of which has yet been discovered.

And therefore (as I have said elsewhere) if a man had been thinking of the war engines and battering-rams of the ancients, though he had done it with all his might and spent his whole life in it, yet he would never have lighted on the discovery of cannon acting by means of gunpowder. Nor again, if he had fixed his observation and thought on the manufacture of wool and cotton, would he ever by such means have discovered the nature of the silkworm or of silk.

Hence it is that all the discoveries which can take rank among the nobler of their kind, have (if you observe) been brought to light, not by small elaborations and extensions of arts, but entirely by accident. Now there is nothing which can forestall or anticipate accident (which commonly acts only at long intervals) except the discovery of Forms.

Particular examples of such instances it is unnecessary to adduce, there is such plenty of them. For what we have to do is simply this: — to seek out and thoroughly inspect all mechanical arts, and all liberal too (as far as they deal with works), and make therefrom a collection or particular history of the great and masterly and most perfect works in every one of them, together with the mode of their production or operation.

And yet I do not tie down the diligence that should be used in such a collection to those works only which are esteemed the masterpieces and mysteries of any art, and which excite wonder. For wonder is the child of rarity; and if a thing be rare, though in kind it be no way extraordinary, yet it is wondered at. While on

the other hand things which really call for wonder on account of the difference in species which they exhibit as compared with other species, yet if we have them by us in common use, are but slightly noticed.

Now the singularities of art deserve to be noticed no less than those of nature, of which I have already spoken. And as among the singularities of nature I placed the sun, the moon, the magnet, and the like, — things in fact most familiar, but in nature almost unique; so also must we do with the singularities of art.

For example, a Singular Instance of art is paper, a thing exceedingly common. Now if you observe them with attention, you will find that artificial materials are either woven in upright and transverse threads, as silk, woollen or linen cloth, and the like; or cemented of concreted juices, as brick, earthen-ware, glass, enamel, porcelain, &c., which are bright if well united, but if not, are hard indeed but not bright. But all things that are made of concrete juices are brittle, and no way cohesive or tenacious. On the contrary paper is a tenacious substance, that may be cut or torn; so that it imitates and almost rivals the skin or membrane of an animal, the leaf of a vegetable, and the like pieces of Nature's workmanship. For it is neither brittle like glass, nor woven as cloth; but is in fibres, not distinct threads, just like natural materials; so that among artifical materials you will hardly find anything similar: but it is altogether singular. And certainly among things artificial those are to be preferred which either come nearest to an imitation of nature, or on the contrary overrule and turn her back.

Again, as instances of the Wit and Hand of Man, we must not altogether contemn juggling and conjur-

ing tricks. For some of them, though in use trivial and ludicrous, yet in regard to the information they give may be of much value.

Lastly, matters of superstition and magic (in the common acceptation of the word) must not be entirely omitted. For although such things lie buried deep beneath a mass of falsehood and fable, yet they should be looked into a little; for it may be that in some of them some natural operation lies at the bottom; as in fascination, strengthening of the imagination, sympathy of things at a distance, transmission of impressions from spirit to spirit no less than from body to body, and the like.

XXXII.

From what has been said it is clear that the five classes of instances last mentioned (namely, Instances Conformable, Singular, Deviating, Bordering, and of Power) ought not to be reserved until some certain nature be in question (as the other instances which I have placed first, and most of those that are to follow should), but a collection of them must be begun at once, as a sort of particular history; because they serve to digest the matters that enter the understanding, and to correct the ill complexion of the understanding itself, which cannot but be tinged and infected, and at length perverted and distorted, by daily and habitual impressions.

These instances therefore should be employed as a sort of preparative for setting right and purging the understanding. For whatever withdraws the understanding from the things to which it is accustomed, smooths and levels its surface for the reception of the dry and pure light of true ideas.

Moreover such instances pave and prepare the way for the operative part; as will be shown in the proper place, when I come to speak of deductions leading to Practice.

XXXIII.

Among Prerogative Instances I will put in the eleventh place *Instances of Companionship and of Enmity;* which I also call Instances of *Fixed Propositions.* They are those which exhibit a body or concrete substance, in which the nature inquired into constantly attends, as an inseparable companion; or in which on the contrary it constantly retreats, and is excluded from companionship, as an enemy and foe. For from such instances are formed certain and universal propositions, either affirmative or negative; in which the subject will be a body in concrete, and the predicate the nature itself that is in question. For particular propositions are in no case fixed; I mean propositions in which the nature in question is found in any concrete body to be fleeting and moveable, that is to say accruing or acquired, or on the other hand departing or put away. Wherefore particular propositions have no prerogative above others, save only in the case of Migration, of which I have already spoken. Nevertheless even these particular propositions being prepared and collated with universal propositions are of great use, as shall be shown in the proper place. Nor even in the universal propositions do we require exact or absolute affirmation or negation. For it is sufficient for the purpose in hand, even if they admit of some rare and singular exception.

The use of Instances of Companionship is to bring the Affirmative of the Form within narrow limits.

For as by Migratory Instances the Affirmative of the Form is narrowed to this, — that the Form of the thing must needs be something which by the act of Migration is communicated or destroyed; so in Instances of Companionship, the Affirmative of the Form is narrowed to this, — that the Form of the thing must needs be something which enters as an element into such a concretion of body, or contrariwise which refuses to enter; so that he who well knows the constitution or configuration of such a body will not be far from bringing to light the Form of the nature under inquiry.

For example, let the nature in question be Heat. An Instance of Companionship is Flame. For in water, air, stone, metal, and most other substances, heat is variable, and may come and go; but all flame is hot, so that heat is always in attendance on the concretion of flame. But no Hostile Instance of Heat is to be found here. For the senses know nothing of the bowels of the earth, and of all the bodies which we do know, there is not a single concretion that is not susceptible of heat.

But to take another instance; let the nature in question be Consistency. A Hostile Instance is Air. For metal can be fluid and can also be consistent; and so can glass; water also can be consistent, when it is frozen; but it is impossible that air should ever be consistent, or put off its fluidity.

But with regard to such Instances of Fixed Propositions I have two admonitions to give, which may help the business in hand. The first is, that if a universal affirmative or negative be wanting, that very thing be carefully noted as a thing that is not; as we

have done in the case of Heat, where a universal negative (as far as the essences that have come under our knowledge are concerned) is not to be found in the nature of things. In like manner, if the nature in question be Eternity or Incorruptibility, no universal affirmative is to be found here. For Eternity or Incorruptibility cannot be predicated of any of the bodies lying below the heavens and above the bowels of the earth. The other admonition is, that to universal propositions, affirmative or negative, concerning any concrete body, there be subjoined those concretes which seem to approach most nearly to that which is not; as in heat, the gentlest and least burning flames; in incorruptibility, gold which comes nearest to it. For all such indicate the limits of nature between that which is and that which is not, and help to circumscribe Forms, and prevent them from escaping and straying beyond the conditions of matter.

XXXIV.

Among Prerogative Instances I will put in the twelfth place those *Subjunctive Instances* mentioned in the last aphorism, which I otherwise call *Instances of Ultimity or Limit*. For such instances are not only useful when subjoined to fixed propositions, but also by themselves and in their own properties. For they point out not obscurely the real divisions of nature and measures of things, and how far in any case nature may act or be acted upon, and then the passages of nature into something else. Of this kind are gold in weight; iron in hardness; the whale in animal bulk; the dog in scent; the combustion of gunpowder in rapid expansion; and the like. Nor should extremes

in the lowest degree be less noticed than extremes in the highest; such as spirit of wine in weight; silk in softness; the worms of the skin in animal bulk; and the like.

XXXV.

Among Prerogative Instances I will put in the thirteenth place *Instances of Alliance or Union.* They are those which mingle and unite natures supposed to be heterogeneous, and marked and set down as such in the received divisions.

Instances of Alliance show that operations and effects attributed to some one heterogeneous nature as peculiar to it, may belong also to other heterogeneous natures; so that this supposed heterogeneity is proved to be not real or essential, but only a modification of a common nature. They are therefore of most excellent use in raising and elevating the understanding from specific differences to *genera*, and in dispelling phantoms and false images of things, which in concrete substances come before us in disguise. For example, let the nature in question be heat. We are told (and it seems to be a division quite received and authorised) that there are three kinds of heat; the heat of heavenly bodies, the heat of animals, and the heat of fire; and that these heats (especially one of them as compared with the other two) are in their very essence and species — that is to say, in their specific nature — distinct and heterogeneous; since the heat of heavenly bodies and of animals generates and cherishes, while the heat of fire wastes and destroys. We have, therefore, an Instance of Alliance in that common case, when the branch of a vine is brought within a house where a fire is constantly kept up, and the grapes ripen

on it a whole month sooner than they do out of doors; so that the ripening of fruit, even while it hangs on the tree, may be brought about by fire, though such ripening would seem to be the proper work of the sun. From this beginning therefore, the understanding, rejecting the notion of essential heterogeneity, easily rises to inquire what are in reality those points of difference between the heat of the sun and of fire which cause their operations to be so dissimilar, however they may themselves partake of a common nature.

These differences will be found to be four. The first is, that the heat of the sun compared with the heat of fire is far milder and softer in degree; the second is, that in quality (at least as it reaches us through the air) it is far moister; the third (and this is the main point) is, that it is exceedingly unequal, now approaching and increased, now receding and diminished; which thing chiefly contributes to the generation of bodies. For Aristotle was right in asserting that the principal cause of the generations and corruptions which are going on here on the surface of the earth is the oblique course of the sun through the zodiac; whence the heat of the sun, partly by the alternation of day and night, partly by the succession of summer and winter, becomes strangely unequal. And yet this great man must go on at once to corrupt and deprave what he has rightly discovered. For laying down the law to nature (as his way is), he very dictatorially assigns as the cause of generation the approach of the sun, and as the cause of corruption his retreat; whereas both together (the approach of the sun and his retreat), not respectively, but as it were indifferently, afford a cause both for generation and production;

since inequality of heat ministers to generation and corruption, equality to conservation only. There is also a fourth specific difference between the heat of the sun and of fire, and one of very great moment; viz. that the sun operates by gentle action through long spaces of time, whereas the operations of fire, urged on by the impatience of man, are made to finish their work in shorter periods. But if any one were to set to work diligently to temper the heat of fire and reduce it to a milder and more moderate degree, as is easily done in many ways; and were then to sprinkle and intermix a little moisture; and if above all he were to imitate the heat of the sun in its inequality; and lastly if he could submit to a slow procedure, not indeed corresponding to the operations of the sun, but yet slower than men generally adopt in working with fire; he would speedily get rid of the notion of different kinds of heat, and would attempt to imitate, if not equal or in some cases even surpass, the works of the sun by the heat of fire. We have a similar Instance of Alliance in the revival of butterflies stupified and half dead with cold, by slightly warming them at a fire; so that you may easily see that fire is no more without the power of giving life to animals than of ripening vegetables. Thus also Fracastorius's celebrated invention of the heated pan with which doctors cover the heads of apoplectic patients who are given over, manifestly expands the animal spirits, compressed and all but extinguished by the humours and obstructions of the brain, and exciting them to motion, just as fire acts on air or water, by consequence quickens and gives them life. Eggs also are sometimes hatched by the heat of fire, which thus exactly imitates animal heat; and there are

many instances of the same kind; so that no one can doubt that the heat of fire may in many subjects be modified so as to resemble the heat of heavenly bodies and of animals.

Again, let the natures in question be Motion and Rest. It appears to be a received division and drawn from the depths of philosophy, that natural bodies either move in circle, or move straight forward, or remain at rest. For there is either motion without limit, or rest at a limit, or progress towards a limit. Now that perpetual motion of rotation seems to be proper to the heavenly bodies; station or rest seems to belong to the globe of the earth; while other bodies (which they call heavy or light, being indeed placed out of the region to which they naturally belong) are carried towards the masses or congregations of their likes; light bodies upwards towards the circumference of the heaven; heavy bodies downwards towards the earth. And this is pretty talk.

But we have an Instance of Alliance in one of the lower comets, which though far below the heaven, nevertheless revolve. And Aristotle's fiction of a comet being tied to or following some particular star has long been exploded, not only because the reason for it is not probable, but because we have manifest experience of the discursive and irregular motion of comets through various parts of the sky.

Again, another Instance of Alliance on this subject is the motion of air, which within the tropics, where the circles of rotation are larger, seems itself also to revolve from east to west.

Again, another Instance would be the ebb and flow of the sea, if it be found that the waters themselves

are carried in a motion of rotation (however slow and evanescent) from east to west; though subject to the condition of being driven back twice in the day. For if things be so, it is manifest that that motion of rotation is not limited to heavenly bodies, but is shared also by air and water.

Even that property of light substances, viz. that they tend upwards, is somewhat at fault. And on this point a bubble of water may be taken as an Instance of Alliance. For if there be air under the water, it rapidly ascends to the surface, by that motion of percussion (as Democritus calls it) by which the descending water strikes and raises the air upwards; not by any effort or struggle of the air itself. And when it is come to the surface of the water, then the air is stopped from further ascent by a slight resistance it meets with in the water, which does not immediately allow itself to be separated; so that the desire of air to ascend must be very slight.

Again, let the nature in question be Weight. It is quite a received division, that dense and solid bodies move toward the centre of the earth, rare and light toward the circumference of the heaven, as to their proper places. Now as for this notion of places, though such things prevail in the schools, it is very silly and childish to suppose that place has any power. Therefore philosophers do but trifle when they say that if the earth were bored through, heavy bodies would stop on reaching the centre. Certainly it would be a wonderful and efficacious sort of nothing, or mathematical point, which could act on bodies, or for which bodies could have desire; for bodies are not acted on except by bodies. But this desire of ascending and de-

scending depends either on the configuration of the body moved or on its sympathy or consent with some other body. Now if there be found any body which, being dense and solid, does not move to the earth, there is an end of this division. But if Gilbert's opinion be received, that the earth's magnetic power of attracting heavy bodies does not extend beyond the orb of its virtue (which acts always to a certain distance and no more), and if this opinion be verified by a single instance, in that we shall have got at last an Instance of Alliance on the subject of weight. But at present there does not occur any instance on this subject certain and manifest. What seems to come nearest to one is that of the waterspouts, often seen in the voyage over the Atlantic Ocean towards either of the Indies. For so great is the quantity and mass of water suddenly discharged by these waterspouts, that they seem to have been collections of water made before, and to have remained hanging in these places; and afterwards to have been rather thrown down by some violent cause, than to have fallen by the natural motion of gravity; so that it may be conjectured that a dense and compact mass, at a great distance from the earth, would hang like the earth itself, and not fall unless thrust down. But on this point I affirm nothing certain. Meanwhile in this and many other cases it will easily be seen how poor we are in natural history, when in place of certain instances I am sometimes compelled to adduce as examples bare suppositions.

Again, let the nature in question be Discourse of Reason. The distinction between human reason and the sagacity of brutes appears to be a perfectly correct one. Yet there are certain instances of actions per-

formed by animals, by which it seems that brutes too have some power of syllogising; as in the old story of the crow which, in a time of great drought being half dead with thirst, saw some water in the hollow trunk of a tree; and finding it too narrow to get in, proceeded to drop in a number of pebbles, till the water rose high enough for it to drink; which thing afterwards passed into a proverb.

Again, let the nature in question be Visibility. It appears to be a very correct and safe division which regards light as primarily visible, and affording the power of seeing; while colour is secondarily visible, and cannot be seen without light, so that it appears to be nothing more than an image or modification of light. And yet there appear to be Instances of Alliance on either side; namely, snow in great quantities, and the flame of sulphur; in one of which there appears to be a colour primarily giving light, in the other a light verging on colour.

XXXVI.

Among Prerogative Instances I will put in the fourteenth place *Instances of the Fingerpost;* borrowing the term from the fingerposts which are set up where roads part, to indicate the several directions. These I also call *Decisive and Judicial*, and in some cases, *Oracular* and *Commanding Instances*. I explain them thus. When in the investigation of any nature the understanding is so balanced as to be uncertain to which of two or more natures the cause of the nature in question should be assigned, on account of the frequent and ordinary concurrence of many natures, Instances of the Fingerpost show the union of one of the natures with

the nature in question to be sure and indissoluble, of the other to be varied and separable; and thus the question is decided, and the former nature is admitted as the cause, while the latter is dismissed and rejected. Such instances afford very great light, and are of high authority, the course of interpretation sometimes ending in them and being completed. Sometimes these Instances of the Fingerpost meet us accidentally among those already noticed; but for the most part they are new, and are expressly and designedly sought for and applied, and discovered only by earnest and active diligence.

For example, let the nature in question be the Ebb and Flow of the Sea; each of which is repeated twice a day, and takes six hours each time; subject to some slight difference which coincides with the motion of the moon. The following will be a case of the parting of the roads.

This motion must necessarily be caused either by the advance and retreat of the waters; as water shaken in a basin leaves one side when it washes the other; or else by a lifting up of the waters from the bottom and falling again; as water in boiling rises and falls. The question is to which of these two causes the ebb and flow should be assigned. Now, if we take the first, it follows that when there is a flood on one side of the sea, there must be at the same time an ebb somewhere on the other. To this point therefore the inquiry is brought. Now it has been observed by Acosta and others, after careful research, that on the shores of Florida and the opposite shores of Spain and Africa the floods take place at the same times, and the ebbs take place at the same times also; and not that there

is an ebb from the shores of Spain and Africa when there is a flood on the shores of Florida. And yet if you look at it more closely, this does not prove the case in favour of the rising and against the progressive motion. For waters may move in progression, and yet rise upon the opposite shores of the same channel at the same time; as when they are thrust together and driven on from some other quarter. For so it is with rivers, which rise and fall on both banks at the same hours; and yet that motion is clearly one of progression; namely, of the waters entering the mouth of the rivers from the sea. It may therefore happen in a like manner that waters coming in a vast mass from the East Indian Ocean are driven together and pushed into the channel of the Atlantic, and on that account flood both sides at once. We must inquire therefore whether there be any other channel, in which the water can be retreating and ebbing at that same time; and we have the South Sea, a sea at least as wide, indeed wider and larger than the Atlantic, which is sufficient for the purpose.

At length then we have come to an Instance of the Fingerpost in this case; and it is this. If we find for certain that when there is a flood on the opposite coasts of Florida and Spain in the Atlantic, there is also a flood on the coasts of Peru and the back of China in the South Sea, then indeed on the authority of this Decisive Instance we must reject the assertion that the ebb and flow of the sea, which is the thing inquired into, takes place by a progressive motion; for there is no sea or place left in which the retreat or ebbing can be going on at the same time. And this may be most conveniently ascertained by asking the inhabitants of

Panama and Lima (where the two Oceans, the Atlantic and Pacific, are separated by a small isthmus) whether the ebb and flow of the sea takes place on the opposite sides of the isthmus at the same time; or contrariwise, when it is ebbing on one side it is flowing on the other. Now this decision or rejection appears to be certain, if we take it for granted that the earth is immoveable. But if the earth revolves, it is perhaps possible that in consequence of the unequal rotation (in point of speed) of the earth and waters of the sea, the waters are violently driven upwards into a heap, which is the flood, and (when they can bear no more piling) released and let down again, which is the ebb. But on this inquiry should be made separately. Still even on this hypothesis, our position remains equally fixed, that there must of necessity be an ebb of the sea going on in some parts at the same time that a flood is going on in others.

Again, let the nature in question be the latter of the two motions we have supposed; namely, the rising and sinking motion; if on careful examination we reject the former motion of which I spoke, — the progressive. With regard to this nature the road branches into three. For the motion by which the waters rise in the flood and sink in the ebb without any accession of other waters rolling in, must necessarily be brought about in one of these three ways. Either there is an accession of water poured out from the interior of the earth, and again retreating into it; or there is no accession to the mass of water, but the same waters (without increase of quantity) are extended or rarefied, so as to occupy a greater space and dimension, and again contract themselves; or there is no increase

either of supply or of extension, but the same waters (the same in quantity as in density) are raised by some magnetic force attracting them from above, and by consent therewith, and then fall back again. Let us now dismiss the two former causes of motion and reduce our inquiry to the last; that is to say, let us inquire whether any such raising by consent or magnetic force may happen. Now in the first place it is evident that the waters, as they lie in the trench or hollow of the sea, cannot all be raised at once, for want of something to take their place at the bottom; so that even if there were in water any such desire to rise, it would be barred and checked by the cohesion of things, or (as it is commonly called) the abhorrence of a vacuum. It remains that the waters must be raised in one part, and thereby be diminished and retreat in another. Again, it will follow of necessity that the magnetic force, since it cannot act upon the whole, will act with the greatest intensity on the middle, so as to raise up the water in the middle; upon which the rest must follow and fall away from the sides.

Thus at length we come to an Instance of the Fingerpost on this subject. For if we find that in the ebb of the sea the surface of the water is more arched and round, the waters rising in the middle of the sea and falling away from the sides, that is, the shores; and that in the flood the same surface is more even and level, the waters returning to their former position; then indeed on the authority of this Decisive Instance the raising by magnetic force may be admitted; otherwise it must be utterly rejected. And this would not be difficult to ascertain by trial in straits with sounding lines; viz. whether during ebbs the sea be not higher

or deeper towards the middle than during floods. It is to be observed however that, if this be the case, the waters must (contrary to the common opinion) rise in ebbs and sink in floods, so as to clothe and wash the shores.

Again, let the nature investigated be the Spontaneous Motion of Rotation; and in particular, whether the Diurnal Motion, whereby to our eyes the sun and stars rise and set, be a real motion of rotation in the heavenly bodies, or a motion apparent in the heavenly bodies, and real in the earth. We may here take for an Instance of the Fingerpost the following. If there be found in the ocean any motion from east to west, however weak and languid; if the same motion be found a little quicker in the air, especially within the tropics, where because of the larger circles it is more perceptible; if the same motion be found in the lower comets, but now lively and vigorous; if the same motion be found in planets, but so distributed and graduated, that the nearer a planet is to the earth its motion is slower, the further a planet is distant from the earth its motion is quicker, and quickest of all in the starry sphere; then indeed we should receive the diurnal motion as real in the heavens, and deny such motion to the earth; because it will be manifest that motion from east to west is perfectly cosmical, and by consent of the universe; being most rapid in the highest parts of the heavens, and gradually falling off, and finally stopping and becoming extinct in the immoveable, — that is, the earth.

Again, let the nature in question be that other Motion of Rotation so much talked of by philosophers, the Resistent and Contrary Motion to the Diurnal, viz.

from west to east; which old philosophers attribute to the planets; also to the starry sphere; but Copernicus and his followers to the earth as well; and let us inquire whether any such motion be found in nature, or whether it be not rather a thing invented and supposed for the abbreviation and convenience of calculation, and for the sake of that pretty notion of explaining celestial motions by perfect circles. For this motion in the heavens is by no means proved to be true and real, either by the failing of a planet to return in its diurnal motion to the same point of the starry sphere, or by this, that the poles of the zodiac differ from the poles of the world; to which two things we owe this idea of motion. For the first phenomenon is well accounted for by supposing that the fixed stars outrun the planets, and leave them behind; the second, by supposing a motion in spiral lines; so that the inequality of return and the declination to the tropics may rather be modifications of the one diurnal motion, than motions contrary or round different poles. And most certain it is, if one may but play the plain man for a moment (dismissing the fancies of astronomers and schoolmen, whose way it is to overrule the senses, often without reason, and to prefer what is obscure), that this motion does actually appear to the sense such as I have described; for I once had a machine made with iron wires to represent it.

The following would be an Instance of the Fingerpost on this subject. If it be found in any history worthy of credit, that there has been any comet, whether high or low, which has not revolved in manifest agreement (however irregular) with the diurnal motion, but has revolved in the opposite direction, then certainly

we may set down thus much as established, that there *may be* in nature some such motion. But if nothing of the kind can be found, it must be regarded as questionable, and recourse be had to other Instances of the Fingerpost about it.

Again, let the nature in question be Weight or Heaviness. Here the road will branch into two, thus. It must needs be that heavy and weighty bodies either tend of their own nature to the centre of the earth, by reason of their proper configuration; or else that they are attracted by the mass and body of earth itself as by the congregation of kindred substances, and move to it by sympathy. If the latter of these be the cause, it follows that the nearer heavy bodies approach to the earth, the more rapid and violent is their motion to it; and that the further they are from the earth, the feebler and more tardy is their motion (as is the case with magnetic attraction); and that this action is confined to certain limits; so that if they were removed to such a distance from the earth that the earth's virtue could not act upon them, they would remain suspended like the earth itself, and not fall at all. With regard to this then, the following would be an Instance of the Fingerpost. Take a clock moved by leaden weights, and another moved by the compression of an iron spring; let them be exactly adjusted, that one go not faster or slower than the other; then place the clock moving by weights on the top of a very high steeple, keeping the other down below; and observe carefully whether the clock on the steeple goes more slowly than it did, on account of the diminished virtue of its weights. Repeat the experiment in the bottom of a mine, sunk to a great depth below the ground; that is,

observe whether the clock so placed does not go faster than it did, on account of the increased virtue of its weights. If the virtue of the weights is found to be diminished on the steeple, and increased in the mine, we may take the attraction of the mass of the earth as the cause of weight.

Again, let the nature investigated be the Polarity of the Iron Needle when touched with the magnet. With regard to this nature the road will branch into two, thus. Either the touch of the magnet of itself invests the iron with polarity to the north and south; or it simply excites and prepares the iron, while the actual motion is communicated by the presence of the earth; as Gilbert thinks, and labours so strenuously to prove. To this point therefore tend the observations which he has collected with great sagacity and industry. One is, that an iron nail, which has lain for a long time in a direction between north and south, gathers polarity without the touch of the magnet by its long continuance in this position; as if the earth itself, which on account of the distance acts but feebly (the surface or outer crust of the earth being destitute, as he insists, of magnetic power), were yet able by this long continuance to supply the touch of the magnet, and excite the iron, and then shape and turn it when excited. Another is, that if iron that has been heated white-hot, be while cooling laid length-wise between north and south, it also acquires polarity without the touch of the magnet; as if the parts of the iron, set in motion by ignition, and afterwards recovering themselves, were at the very moment of cooling more susceptible and sensitive of the virtue emanating from the earth than at other times, and thus became excited by it. But these

things, though well observed, do not quite prove what he asserts.

Now with regard to this question an Instance of the Fingerpost would be the following. Take a magnetic globe and mark its poles; and set the poles of the globe towards the east and west, not towards the north and south, and let them remain so; then place at the top an untouched iron needle, and allow it to remain in this position for six or seven days.

The needle while over the magnet (for on this point there is no dispute) will leave the poles of the earth and turn towards the poles of the magnet; and therefore, as long as it remains thus, it points east and west. Now if it be found that the needle, on being removed from the magnet and placed on a pivot, either starts off at once to the north and south, or gradually turns in that direction, then the presence of the earth must be admitted as the cause; but if it either points as before east and west, or loses its polarity, this cause must be regarded as questionable, and further inquiry must be made.

Again, let the nature in question be the Corporeal Substance of the Moon; that is, let us inquire whether it be rare, consisting of flame or air, as most of the old philosophers opined; or dense and solid, as Gilbert and many moderns, with some ancients, maintain. The reasons for the latter opinion rest chiefly on this, that the moon reflects the rays of the sun; nor does light seem to be reflected except by solid bodies. Therefore Instances of the Fingerpost on this question will (if any) be those which prove that reflexion may take place from a rare body, as flame, provided it be of sufficient denseness. Certainly one cause of twilight,

among others, is the reflexion of the rays of the sun from the upper part of the air. Likewise we occasionally see rays of the sun in fine evenings reflected from the fringes of dewy clouds with a splendour not inferior to that reflected from the body of the moon, but brighter and more gorgeous; and yet there is no proof that these clouds have coalesced into a dense body of water. Also we observe that the dark air behind a window at night reflects the light of a candle, just as a dense body would. We should also try the experiment of allowing the sun's rays to shine through a hole on some dusky blueish flame. For indeed the open rays of the sun, falling on the duller kinds of flame, appear to deaden them, so that they seem more like white smoke than flame. These are what occur to me at present as Instances of the Fingerpost, with reference to this question; and better may perhaps be found. But it should always be observed that reflexion from flame is not to be expected, except from a flame of some depth; for otherwise it borders on transparency. This however may be set down as certain, — that light on an even body is always either received and transmitted or reflected.

Again let the nature in question be the Motion of Projectiles (darts, arrows, balls, &c.) through the air. This motion the schoolmen, as their way is, explain in a very careless manner; thinking it enough to call it a violent motion as distinguished from what they call a natural motion; and to account for the first percussion or impulse by the axiom that two bodies cannot occupy the same place on account of the impenetrability of matter; and not troubling themselves at all how the motion proceeds afterwards. But with refer-

ence to this inquiry the road branches into two in this way. Either this motion is caused by the air carrying the projected body and collecting behind it, as the stream in the case of a boat, or the wind in that of straws; or it is caused by the parts of the body itself not enduring the impression, but pushing forward in succession to relieve themselves from it. The former of these explanations is adopted by Fracastorius and almost all who have entered into the investigation with any subtlety, and there is no doubt that the air *has* something to do with it: but the other motion is undoubtedly the true one, as is shown by countless experiments. Among others the following would be an Instance of the Fingerpost on this subject: that a thin iron plate or stiffish iron wire, or even a reed or pen split in half, when pressed into a curve between the finger and thumb, leaps away. For it is obvious that this motion cannot be imputed to the air gathering behind the body, because the source of motion is in the middle of the plate or reed, not in the extremities.

Again, let the nature in question be the rapid and powerful motion of the Expansion of Gunpowder into flame; by which such vast masses are upheaved, such great weights discharged, as we see in mines and mortars. With respect to this nature the road branches into two in this way. The motion is excited either by the mere desire of the body to expand when set on fire, or partly by that and partly by the desire of the crude spirit in the body, which flies rapidly away from the fire, and bursts violently from its embrace as from a prison-house. The schoolmen and common opinion deal only with the former desire. For men fancy themselves very fine philosophers, when they assert that the

flame is endowed by its elementary form with a necessity of occupying a larger space than the body had filled when in the form of powder, and that hence the motion ensues. Meanwhile they forget to notice, that although this be true on the supposition that flame is generated, it is yet possible for the generation of flame to be hindered by a mass of matter sufficient to suppress and choke it; so that the case is not reduced to the necessity they insist on. For that expansion must necessarily take place, and that there must needs follow thereon a discharge or removal of the opposing body, if flame be generated, they rightly judge. But this necessity is altogether avoided if the solid mass suppress the flame before it be generated. And we see that flame, especially in its first generation, is soft and gentle, and requires a hollow space wherein to play and try its strength. Such violence therefore cannot be attributed to flame by itself. But the fact is, that the generation of these windy flames, or fiery winds as they may be called, arises from a conflict of two bodies of exactly opposite natures; the one being highly inflammable, which is the nature of sulphur, the other abhorring flame, as the crude spirit in nitre; so that there ensues a strange conflict, the sulphur kindling into flame with all its might (for the third body, the willow-charcoal, does no more than incorporate and combine the other two), while the spirit of the nitre bursts forth with all its might, and at the same time dilates itself (as air, water, and all crude bodies do when affected by heat), and by thus flying and bursting out fans meanwhile the flame of the sulphur on all sides as with hidden bellows.

On this subject we may have Instances of the Finger-

post of two kinds. The first, of those bodies which are most highly inflammable, as sulphur, camphor, naphtha and the like, with their compounds; which catch fire more quickly and easily than gunpowder if not impeded (from which it appears that the desire of bursting into flame does not produce by itself that stupendous effect); the other, of those bodies which shun and abhor flame, as all salts. For we find that if salts are thrown into the fire, their aqueous spirit bursts out with a crackling noise, before flame is caught; which is the case also, though in a milder degree, with the stiffer kinds of leaves: the aqueous part escaping before the oily catches fire. But this is best seen in quicksilver, which is not inaptly called mineral water. For quicksilver, without bursting into flame, by mere eruption and expansion almost equals the force of gunpowder, and is also said when mixed with gunpowder to increase its strength.

Again, let the nature in question be the Transitory Nature of Flame and its momentaneous extinction. For the nature of flame appears to have no fixed consistency here with us, but to be every moment generated and every moment extinguished; for it is clear that in flames which continue and last, the continuance we see is not of the same individual flame, but is caused by a succession of new flame regularly generated; nor does the flame remain numerically identical; as is easily seen from this, that if the food or fuel of flame be taken away, the flame instantly goes out. With reference to this nature the roads branch into two, thus. The momentaneous nature proceeds either from a cessation of the cause which at first produced the flame, as in light, sound, and the motion called "violent;" or from this, that the flame, though able by its own nature to re-

main with us, suffers violence and is destroyed by the contrary natures that surround it.

On this subject therefore we may take the following as an Instance of the Fingerpost. We see in large fires how high the flames ascend; for the broader the base of the flame, the higher is its vertex. Thus extinction appears to commence at the sides, where the flame is compressed and troubled by the air. But the heart of the flame, which is not touched by the air but surrounded by other flame on all sides, remains numerically identical; nor is it extinguished until gradually compressed by the surrounding air. Thus all flame is in the form of a pyramid, being broader at the base where the fuel is, but sharp at the vertex, where the air is antagonistic and fuel is wanting. But smoke is narrow at the base and grows broader as it ascends, like an inverted pyramid; the reason being that the air admits smoke and compresses flame. For let no one dream that lighted flame is air, when in fact they are substances quite heterogeneous.

But we may have an Instance of the Fingerpost more nicely adapted to this purpose, if the thing can be made manifest with bicoloured lights. Fix a lighted wax taper in a small metal stand; place the stand in the middle of a bowl, and pour round it spirit of wine, but not enough to reach the top of the stand. Then set fire to the spirit of wine. The spirit of wine will yield a blueish, the taper a yellow flame. Observe therefore whether the flame of the taper (which is easily distinguished by its colour from the flame of the spirit of wine, since flames do not mix at once, as liquids do) remains in a conical or rather tends to a globular form, now that there is nothing to destroy or

compress it. If the latter is found to be the case, it may be set down as certain that flame remains numerically identical as long as it is enclosed within other flame and feels not the antagonistic action of the air.

Let this suffice for Instances of the Fingerpost. I have dwelt on them at some length, to the end that men may gradually learn and accustom themselves to judge of nature by Instances of the Fingerpost and Experiments of Light, and not by probable reasonings.

XXXVII.

Among Prerogative Instances I will put in the fifteenth place *Instances of Divorce;* which indicate the separation of natures of most familiar occurrence. They differ from the instances subjoined to the Instances of Companionship, in that the latter indicate the separation of a nature from some concrete substance with which it is ordinarily in conjunction, while these instances indicate the separation of one nature from another. They differ from Instances of the Fingerpost, in that they determine nothing, but simply notify the separability of one nature from another. Their use is to detect false forms, and to dissipate slight theories suggested by what lies on the surface, and so serve as ballast to the understanding.

For example, let the natures investigated be those four natures which Telesius accounts as messmates and chamber-fellows; namely, Heat, Brightness, Rarity, Mobility or promptness to motion. We find however many Instances of Divorce between them. For air is rare and mobile, not hot or bright; the moon is bright without heat; boiling water is hot without light; the motion of an iron needle on a pivot is quick and nim-

ble, and yet the body is cold, dense and opaque; and there are many more of the kind.

Again, let the natures investigated be Corporeal Nature and Natural Action. For it seems that natural action is not found except as subsisting in some body. Yet in this case also we shall perhaps be able to find some Instance of Divorce; such, for example, as magnetic action, by which iron is drawn to the magnet, heavy bodies to the globe of the earth. There may also be added some other operations performed at a distance. For such action takes place both in time, occupying moments not a mere instant of time; and in space, passing through degrees and distances. There is therefore some moment of time, and some distance of space, in which the virtue or action remains suspended between the two bodies which produce the motion. The question therefore is brought to this; whether the bodies which are the limits of the motion dispose or alter the intermediate bodies, so that by a succession of actual contacts the virtue passes from limit to limit, meanwhile subsisting in the intermediate body; or whether there is no such thing, but only the bodies, the virtue, and the distances. In rays of light indeed, and sounds, and heat, and certain other things acting at a distance, it is probable that the intermediate bodies are disposed and altered; the more so, because they require a medium qualified for carrying on the operation. But that magnetic or attractive virtue admits of media without distinction, nor is the virtue impeded in any kind of medium. And if the virtue or action has nothing to do with the intermediate body, it follows that there is a natural virtue or action subsisting for a certain time and in a certain space without

a body; since it neither subsists in the limiting nor in the intermediate bodies. And therefore magnetic action may be an Instance of Divorce between corporeal nature and natural action. To which may be appended as a corollary or advantage not to be omitted, that here is a proof furnished by merely human philosophy of the existence of essences and substances separate from matter and incorporeal. For allow that a natural virtue and action, emanating from a body, can exist for a certain time and in a certain space altogether without a body, and you are not far from allowing that it can also emanate originally from an incorporeal substance. For corporeal nature appears to be no less requisite for sustaining and conveying natural action, than for exciting or generating it.

XXXVIII.

Now follow five classes of instances which under one general name I call *Instances of the Lamp*, or *of First Information*. They are those which aid the senses. For since all Interpretation of Nature commences with the senses, and leads from the perceptions of the senses by a straight, regular, and guarded path to the perceptions of the understanding, which are true notions and axioms, it follows of necessity that the more copious and exact the representations of the senses, the more easily and prosperously will everything proceed.

Of these five Instances of the Lamp, the first strengthen, enlarge, and rectify the immediate actions of the senses; the second make manifest things which are not directly perceptible by means of others which are; the third indicate the continued processes or series of those things and motions which are for the most

part unobserved except in their end or periods; the fourth provide the sense with some substitute when it utterly fails; the fifth excite the attention and notice of the sense, and at the same time set bounds to the subtlety of things. Of these I shall now speak in their order.

XXXIX.

Among Prerogative Instances I will put in the sixteenth place *Instances of the Door or Gate*, this being the name I give to instances which aid the immediate actions of the senses. Now of all the senses it is manifest that sight has the chief office in giving information. This is the sense therefore for which we must chiefly endeavour to procure aid. Now the aids to sight are of three kinds; it may be enabled to perceive objects that are not visible; to perceive them further off; and to perceive them more exactly and distinctly.

Of the first kind (not to speak of spectacles and the like, which serve only to correct or relieve the infirmity of a defective vision, and therefore give no more information) are those recently invented glasses which disclose the latent and invisible minutiæ of bodies, and their hidden configurations and motions, by greatly increasing their apparent size; instruments by the aid of which the exact shape and outline of body in a flea, a fly, a worm, and also colours and motions before unseen, are not without astonishment discerned. It is also said that a straight line drawn with a pen or pencil is seen through such glasses to be very uneven and crooked; the fact being that neither the motion of the hand, though aided by a ruler, nor the impression of the ink or colour, is really even; although the unevenness is so minute that it cannot be detected without such

glasses. And here (as is usual in things new and wonderful) a kind of superstitious observation has been added; viz. that glasses of this sort do honour to the works of nature, but dishonour to the works of art. The truth however is only this, that natural textures are far more subtle than artificial. For the microscope, the instrument I am speaking of, is only available for minute objects; so that if Democritus had seen one, he would perhaps have leaped for joy, thinking a way was now discovered of discerning the atom, which he had declared to be altogether invisible. The incompetency however of such glasses, except for minutiæ alone, and even for them when existing in a body of considerable size, destroys the use of the invention. For if it could be extended to larger bodies, or to the minutiæ of larger bodies, so that the texture of a linen cloth could be seen like network, and thus the latent minutiæ and inequalities of gems, liquors, urine, blood, wounds, &c. could be distinguished, great advantages might doubtless be derived from the discovery.

Of the second kind are those other glasses discovered by the memorable efforts of Galileo, by the aid of which, as by boats or vessels, a nearer intercourse with the heavenly bodies can be opened and carried on. For these show us that the milky way is a group or cluster of small stars entirely separate and distinct; of which fact there was but a bare suspicion among the ancients. They seem also to point out that the spaces of the planetary orbits, as they are called, are not altogether destitute of other stars, but that the heaven begins to be marked with stars before we come to the starry sphere itself; although with stars too small to be seen without these glasses. With this instrument we can descry

those small stars wheeling as in a dance round the planet Jupiter; whence it may be conjectured that there are several centres of motion among the stars. With this the inequalities of light and shade in the moon are more distinctly seen and placed; so that a sort of selenography can be made. With this we descry spots in the sun, and similar phenomena; all indeed noble discoveries, so far as we may safely trust to demonstrations of this kind; which I regard with suspicion chiefly because the experiment stops with these few discoveries, and many other things equally worthy of investigation are not discovered by the same means.

Of the third kind are measuring rods, astrolabes, and the like; which do not enlarge the sense of sight, but rectify and direct it. And if there are other instances which aid the remaining senses in their immediate and individual actions, and yet are of a kind which add nothing to the information already possessed, they are not to the present purpose; and therefore I have omitted to mention them.

XL.

Among Prerogative Instances I will put in the seventeenth place *Summoning Instances*, borrowing the name from the courts of law; because they summon objects to appear which have not appeared before; I also call them *Evoking Instances*. They are those which reduce the non-sensible to the sensible; that is, make manifest things not directly perceptible by means of others which are.

An object escapes the senses, either on account of its distance; or on account of the interposition of in-

termediate bodies; or because it is not fitted for making an impression on the sense; or because it is not sufficient in quantity to strike the sense; or because there is not time enough for it to act on the sense; or because the impression of the object is such as the sense cannot bear; or because the sense has been previously filled and occupied by another object, so that there is not room for a new motion. These cases have reference principally to the sight, and secondarily to the touch. For these two senses give information at large, and concerning objects in general; whereas the other three give no information hardly, but what is immediate and relates to their proper objects.

In the first kind, where an object is imperceptible by reason of its distance, there is no way of manifesting it to the sense but by joining to it or substituting for it some other object which may challenge and strike the sense from a greater distance; as in communication by beacons, bells, and the like.

In the second kind, this reduction or secondary manifestation is effected when objects that are concealed by the interposition of bodies within which they are enclosed, and cannot conveniently be opened out, are made manifest to the sense by means of those parts of them which lie on the surface, or make their way from the interior. Thus the condition of the human body is known by the state of the pulse, urine, and the like.

In the third and fourth kind, reductions are applicable to a great many things, and in the investigations of nature should be sought for on all sides. For example, it is obvious that air and spirit, and like bodies, which in their entire substance are rare and subtle, can neither be seen nor touched. Therefore in the in-

vestigation of bodies of this kind it is altogether necessary to resort to reductions.

Thus let the nature in question be the Action and Motion of the Spirit enclosed in tangible bodies. For everything tangible that we are acquainted with contains an invisible and intangible spirit, which it wraps and clothes as with a garment. Hence that threefold source, so potent and wonderful, of the process of the spirit in a tangible body. For the spirit in a tangible substance, if discharged, contracts bodies and dries them up; if detained, softens and melts them; if neither wholly discharged nor wholly detained, gives them shape, produces limbs, assimilates, digests, ejects, organises, and the like. And all these processes are made manifest to the sense by conspicuous effects.

For in every tangible inanimate body the enclosed spirit first multiplies itself, and as it were feeds upon those tangible parts which are best disposed and prepared for that purpose; and so digests and elaborates and turns them into spirit; and then they escape together. Now this elaboration and multiplication of the spirit is made manifest to the sense by diminution of weight. For in all desiccation there is some decrease of quantity; not only of the quantity of spirit previously existing in the body, but also of the body itself, which was before tangible and is newly changed; for spirit is without weight. Now the discharge or emission of the spirit is made manifest to the sense in the rust of metals and other similar putrefactions, which stop short before they come to the rudiments of life; for these belong to the third kind of process. For in compact bodies the spirit finds no pores or passages through which to escape, and is therefore compelled to

push and drive before it the tangible parts themselves, so that they go out along with it; whence proceed rust and the like. On the other hand the contraction of the tangible parts, after some of the spirit is discharged (upon which desiccation ensues), is made manifest to the sense not only by the increased hardness of the body, but much more by the rents, contractions, wrinklings, and shrivellings in the body which thereupon take place. For the parts of wood split asunder and are contracted; skins shrivel; and not only that, but if the spirit is suddenly discharged by the heat of fire, they hasten so fast to contraction as to curl and roll themselves up.

On the contrary, where the spirit is detained, and yet expanded and excited by heat or something analogous thereto (as happens in the more solid or tenacious bodies), then are bodies softened, as iron white hot; or they become fluid, as metals; or liquid, as gums, wax, and the like. Thus the contrary operations of heat, which hardens some substances and melts others, are easily reconciled; since in the former the spirit is discharged, in the latter it is excited and detained; whereof the melting is the proper action of the heat and spirit; the hardening is the action of the tangible parts only on occasion of the discharge of the spirit.

But when the spirit is neither wholly detained nor wholly discharged, but only makes trials and experiments within its prison-house, and meets with tangible parts that are obedient and ready to follow, so that whithersoever the spirit leads they go along with it, then ensues the forming of an organic body, and the development of organic parts, and all the other vital actions as well in vegetable as in animal substances.

And these operations are made manifest to the sense chiefly by careful observation of the first beginnings and rudiments or essays of life in animalculæ generated from putrefaction; as in ants' eggs, worms, flies, frogs after rain, &c. There is required however for the production of life both mildness in the heat and pliancy in the substance, that the spirit may neither be so hurried as to break out, nor be confined by the obstinacy of the parts; but may rather be able to mould and model them like wax.

Again, that most noble distinction of spirit which has so many applications (viz. spirit cut off; spirit simply branching; spirit at once branching and cellulate; of which the first is the spirit of all inanimate substances, the second of vegetables, the third of animals), is brought as it were before the eyes by several instances of this kind of reduction.

In like manner it appears that the more subtle textures and configurations of things (though the entire body be visible or tangible) are perceptible neither to the sight nor touch. And therefore in these also our information comes by way of reduction. Now the most radical and primary difference between configurations is drawn from the abundance or scantiness of the matter occupying the same space or dimensions. For all other configurations (which have reference to the dissimilarity of the parts contained in the same body, and to their collocation and position) are but secondary in comparison with the former.

Thus let the nature in question be the Expansion or Coition of Matter in bodies compared one with another; viz. how much matter occupies how much space in each. For there is nothing more true in nature than

the twin propositions, that "nothing is produced from nothing," and "nothing is reduced to nothing," but that the absolute quantum or sum total of matter remains unchanged, without increase or diminution. Nor is it less true that of that quantum of matter more or less is contained under the same space or dimensions according to the diversity of bodies; as in water more, in air less; so that to assert that a given volume of water can be changed into an equal volume of air is as much as to say that something can be reduced to nothing; as on the other hand to maintain that a given volume of air can be turned into an equal volume of water, is the same as to say that something can be produced out of nothing. And it is from this abundance and scantiness of matter, that the abstract notions of Dense and Rare, though variously and promiscuously used, are properly speaking derived. We must also take for granted a third proposition which is also sufficiently certain; viz. that this greater or less quantity of matter in this or that body is capable of being reduced by comparison to calculation and to exact or nearly exact proportions. Thus one would be justified in asserting that in any given volume of gold there is such an accumulation of matter, that spirit of wine, to make up an equal quantity of matter, would require twenty-one times the space occupied by the gold.

Now the accumulation of matter and its proportions are made manifest to the sense by means of weight. For the weight answers to the quantity of matter, in the parts of a tangible body; whereas spirit and the quantum of matter which it contains cannot be computed by weight; for it rather diminishes the weight than increases it. But I have drawn up a very accu-

rate Table on this subject; in which I have noted down the weights and volumes of all the metals, the principal stones, woods, liquors, oils, and many other bodies as well natural as artificial; a thing of great use in many ways, as well for light of information as for direction in practice; and one that discloses many things quite beyond expectation. Not the least important of which is this—it shows that all the variety in tangible bodies known to us (such bodies I mean as are tolerably compact and not quite spongy and hollow, and chiefly filled with air) does not exceed the limit of the ratio of 1 to 21:—so limited is nature, or at any rate that part of it with which we have principally to do.

I have also thought it worth while to try whether the proportions can be calculated which intangible or pneumatic bodies bear to bodies tangible. This I attempted by the following contrivance. I took a glass phial, capable of holding about an ounce; using a small vessel, that less heat might be required to produce evaporation. This phial I filled with spirit of wine almost to the neck; selecting spirit of wine, because I found by the former Table that of all tangible bodies (which are well united and not hollow) this is the rarest, and contains the least quantity of matter in a given space. After that, I noted exactly the weight of the spirit and phial together. I then took a bladder, capable of holding about a quart; from which I squeezed out, as well as I could, all the air, until the two sides of the bladder met. The bladder I had previously rubbed over gently with oil, to make it closer; and having thus stopped up the pores, if there were any, I inserted the mouth of the phial within the mouth of the bladder, and tied the latter tightly round

the former with a thread, smeared with wax in order that it might stick more closely and tie more firmly. After this I set the phial on a chafing dish of hot coals. Presently the steam or breath of the spirit of wine, which was dilated and rendered pneumatic by the heat, began gradually to expand the bladder, and swelled it out on all sides like a sail. When this took place, I immediately took the glass off the fire placing it on a carpet, that it might not crack with the cold; at the same time making a hole in the bladder, lest the steam should turn liquid again on the cessation of the heat, and so disturb the calculations. I then removed the bladder, and weighing the spirit of wine which remained, computed how much had been converted into steam or air. Then comparing the space which the body had occupied while it was spirit of wine in the phial, with the space which it afterwards occupied when it had become pneumatic in the bladder, I computed the results; which showed clearly, that the body had acquired by the change a degree of expansion a hundred times greater than it had had before.

Again, let the nature in question be Heat or Cold, in a degree too weak to be perceptible to the sense. These are made manifest to the sense by a calendar glass such as I have described above. For the heat and cold are not themselves perceptible to the touch, but the heat expands the air, and the cold contracts it. Nor again is this expansion and contraction of the air perceptible to the sight; but the expansion of the air depresses the water, the contraction raises it; and so at last is made manifest to the sight; not before, nor otherwise.

Again, let the nature in question be the Mixture of

Bodies; viz. what they contain of water, oil, spirit, ash, salt, and the like; or (to take a particular instance) what quantity of butter, curd, whey, &c., is contained in milk. These mixtures, so far as relates to tangible elements, are made manifest to the sense by artificial and skilful separations. But the nature of the spirit in them, though not immediately perceived, is yet discovered by the different motions and efforts of the tangible bodies in the very act and process of their separation; and also by the acridities and corrosions, and by the different colours, smells, and tastes of the same bodies after separation. And in this department men have laboured hard, it is true, with distillations and artificial separations, but not with much better success than in the other experiments which have been hitherto in use; for they have but groped in the dark, and gone by blind ways, and with efforts painstaking rather than intelligent; and (what is worst of all) without attempting to imitate or emulate nature, but rather destroying by the use of violent heats and overstrong powers all that more subtle configuration in which the occult virtues and sympathies of things chiefly reside. Nor do they remember or observe, while making such separations, the circumstance which I have elsewhere pointed out, — namely, that when bodies are tormented by fire or other means, many qualities are communicated by the fire itself, and by the bodies employed to effect the separation, which did not exist previously in the compound; whence strange fallacies have arisen. For it must not be supposed that all the vapour which is discharged from water by the action of fire, was formerly vapour or air in the body of the water; the fact being that the greatest part of

it was created by the expansion of the water from the heat of the fire.

So in general, all the nice tests of bodies whether natural or artificial, by which the genuine are distinguished from the adulterated, the better from the viler sort, should be referred to this division; for they make manifest to the sense things not directly perceptible, by means of those which are. They should therefore be sought and collected from all quarters with diligent care.

With regard to the fifth way in which objects escape the sense, it is obvious that the action of sense takes place in motion, and that motion takes place in time. If therefore the motion of any body be either so slow or so quick that it bears no proportion to the moments which the sense takes to act in, the object is not perceived at all; as in the motion of the hand of a clock, and again in the motion of a musket ball. Now motion which is too slow to be perceived is easily and usually made manifest to the sense by means of aggregates of motion. Motion which is too quick has not hitherto been competently measured; and yet the investigation of nature requires that this be done in some cases.

In the sixth kind, where the sense is hindered by the too great power of the object, the reduction may be effected either by removing the object to a greater distance from the sense; or by deadening its effects by the interposition of a medium which will weaken without annihilating the object; or by admitting and receiving the reflexion of the object, where the direct impression is too powerful; as that of the sun for instance in a basin of water.

The seventh cause, where the sense is so charged with one object that it has no room for the admission of another, is almost wholly confined to the sense of smell, and has little to do with the matter in hand. So much then for the reduction of the non-sensible to the sensible, — or the modes of making manifest to the sense things not directly perceptible by means of others which are.

Sometimes however the reduction is made not to the sense of a man, but of some other animal, whose sense in some cases is keener than man's; as of certain scents to the sense of a dog; of the light which is latent in air when not illumined from without to the sense of a cat, owl, and similar animals, which see in the dark. For Telesius has justly observed, that there is in the air itself a certain original light, though faint and weak, and hardly of any use to the eyes of men and most animals; inasmuch as animals to whose sense this light is adapted see in the dark, which it is hardly to be believed they do either without light, or by a light within.

Observe also, that at present I am dealing with the deficiencies of the senses and their remedies. The deceptions of the senses must be referred to the particular inquiries concerning sense and the objects of sense; excepting only that grand deception of the senses, in that they draw the lines of nature with reference to man and not with reference to the universe; and this is not to be corrected except by reason and universal philosophy.

XLI.

Among Prerogative Instances I will put in the eighteenth place *Instances of the Road;* which I also call

Travelling Instances and *Articulate Instances.* They are those which point out the motions of nature in their gradual progress. This class of instances escapes the observation rather than the sense. For it is strange how careless men are in this matter; for they study nature only by fits and at intervals, and when bodies are finished and completed, not while she is at work upon them. Yet if any one were desirous of examining and studying the contrivances and industry of an artificer, he would not be content with beholding merely the rude materials of the art, and then the completed works; but would rather wish to be present while the artificer was at his labours and carrying his work on. And a like course should be taken with the investigation of nature. For instance, if we are inquiring into the vegetation of plants, we must begin from the very sowing of the seed, and observe (as we may easily do, by taking out day after day the seeds that have lain in the ground two days, three days, four days, and so on, and carefully examining them) how and when the seed begins to puff and swell, and to be as it were filled with spirit; secondly, how it begins to burst the skin and put forth fibres, at the same time raising itself slightly upwards, unless the ground be very stiff; also, how it puts forth its fibres, some for the root downwards, and some for the stem upwards, and sometimes also creeping sideways, if it there finds the ground more open and yielding; with many other things of the kind. In the same way we should examine the hatching of eggs, in which we might easily observe the whole process of vivification and organisation, and see what parts proceed from the yolk, and what from the white of the egg, and so forth. A similar course should be

taken with animals generated from putrefaction. For to prosecute such inquiries concerning perfect animals by cutting out the fœtus from the womb would be too inhuman, except when opportunities are afforded by abortions, the chase, and the like. There should therefore be set a sort of night watch over nature, as showing herself better by night than by day. For these may be regarded as night studies by reason of the smallness of our candle and its continual burning.

The same too should be attempted with inanimate substances; as I have done myself in investigating the expansion of liquids by fire. For there is one mode of expansion in water, another in wine, another in vinegar, another in verjuice; and quite another in milk and oil; as was easily to be seen by boiling them over a slow fire, and in a glass vessel, in which everything may be clearly distinguished. These matters however I touch but briefly; meaning to treat of them more fully and exactly when I come to the discovery of the *Latent Process* of things. For it should all along be borne in mind that in this place I am not handling the things themselves, but only giving examples.

XLII.

Among Prerogative Instances I will put in the nineteenth place *Supplementary* or *Substitutive Instances;* which I also call *Instances of Refuge.* They are those which supply information when the senses entirely fail us; and therefore we fly to them when appropriate instances are not to be had. Now Substitution is made in two ways; either by gradual approximation or by analogy. To take an example. There is no medium known by the interposition of which the operation of

the magnet in drawing iron is entirely prevented. Gold placed between does not stop it, nor silver, nor stone, nor glass, wood, water, oil, cloth or fibrous substances, air, flame, &c. But yet by nice tests some medium may possibly be found to deaden its virtue more than any other; comparatively, that is, and in some degree. Thus it may be that the magnet would not attract iron as well through a mass of gold, as through an equal space of air, or through ignited silver as well as through cold; and so in other cases. For I have not made the trial myself in these cases. It is enough to propose such experiments by way of example. Again there is no body we are acquainted with which does not contract heat on being brought near the fire. And yet air contracts heat much more quickly than stone. Such is the Substitution which is made by gradual approximation.

Substitution by analogy is doubtless useful, but is less certain, and should therefore be applied with some judgment. It is employed, when things not directly perceptible are brought within reach of the sense, not by perceptible operations of the imperceptible body itself, but by observation of some cognate body which is perceptible. For example, suppose we are inquiring into the Mixture of Spirits, which are invisible bodies; there seems to be a certain affinity between bodies and the matter that feeds or nourishes them. Now the food of flame seems to be oil and fat substances; of air, water and watery substances; for flame multiplies itself over exhalations of oil, air over the vapour of water. We should therefore look to the mixture of water and oil, which manifests itself to the sense; since the mixture of air and flame escapes the sense. Now oil and

water, which are mingled together very imperfectly by composition or agitation, are in herbs and blood and the parts of animals, very subtly and finely mingled. It is possible therefore that something similar may be the case with the mixture of flame and air in pneumatic bodies; which, though not readily mingling by simple commixture, yet seem to be mingled together in the spirits of plants and animals; especially as all animate spirit feeds on moist substances of both kinds, watery and fat, as its proper food.

Again, if the inquiry be not into the more perfect mixtures of pneumatic bodies, but simply into their composition; that is, whether they be readily incorporated together; or whether there be not rather, for example, certain winds and exhalations or other pneumatic bodies which do not mix with common air, but remain suspended and floating therein in globules and drops; and are rather broken and crushed by the air than admitted into or incorporated with it; this is a thing which cannot be made manifest to the senses in common air and other pneumatic bodies, by reason of their subtlety; yet how far the thing may take place we may conceive, by way of image or representation, from what takes place in such liquids as quicksilver, oil, or water; and likewise from the breaking up of air when it is dispersed in water and rises in little bubbles; and again in the thicker kinds of smoke; and lastly in dust raised and floating in the air; in all of which cases no incorporation takes place. Now the representation I have described is not a bad one for the matter in question, provided that diligent inquiry has been first made whether there can be such a heterogeneity in pneumatic bodies as we find there is in liquids; for if there

can, then these images by analogy may not inconveniently be substituted.

But with regard to these Supplementary Instances, although I stated that information was to be derived from them in the absence of instances proper, as a last resource; yet I wish it to be understood that they are also of great use, even when proper instances are at hand; for the purpose, I mean, of corroborating the information which the others supply. But I shall treat of them more fully, when I come in due course to speak of the *Supports of Induction.*

XLIII.

Among Prerogative Instances I will put in the twentieth place *Dissecting Instances;* which I also call *Awakening Instances*, but for a different reason. I call them Awakening, because they awaken the understanding; Dissecting, because they dissect nature; for which reason also I sometimes call them *Democritean.* They are those which remind the understanding of the wonderful and exquisite subtlety of nature, so as to stir it up and awaken it to attention and observation and due investigation. Such, for example, as these following: that a little drop of ink spreads to so many letters or lines; that silver gilt stretches to such a length of gilt wire; that a tiny worm, such as we find in the skin, possesses in itself both spirit and a varied organisation; that a little saffron tinges a whole hogshead of water; that a little civet or musk scents a much larger volume of air; that a little incense raises such a cloud of smoke; that such exquisite differences of sounds, as articulate words, are carried in every direction through the air, and pierce even, though considerably weakened,

through the holes and pores of wood and water; and are moreover echoed back, and that too with such distinctness and velocity; that light and colour pass through the solid substances of glass and water so speedily, and in so wide an extent, and with such copious and exquisite variety of images, and are also refracted and reflected; that the magnet acts through bodies of all sorts, even the most compact; and yet (which is more strange) that in all these, passing as they do through an indifferent medium (such as the air is), the action of one does not much interfere with the action of another; that is to say, that at the same time there are carried through spaces of air so many images of visible objects, so many impressions of articulate sound, so many distinct odours, as of a violet, rose, &c.; moreover heat and cold, and magnetic influences; all (I say) at once without impeding one another, just as if they had their own roads and passages set apart, and none ever struck or ran against other.

To these Dissecting Instances it is useful however to subjoin instances which I call Limits of Dissection; as that in the cases abòve mentioned, though one action does not disturb or impede another action of a different kind; yet one action does overpower and extinguish another action of the same kind; as the light of the sun extinguishes that of a glowworm; the report of a cannon drowns the voice; a strong scent overpowers a more delicate one; an intense heat a milder one; a plate of iron interposed between a magnet and another piece of iron destroys the action of the magnet. But this subject also will find its proper place among the Supports of Induction.

XLIV.

So much for instances which aid the senses; instances which are chiefly useful for the Informative Part of our subject. For information commences with the senses. But the whole business terminates in Works; and as the former is the beginning, so the latter is the end of the matter. I will proceed therefore with the instances which are preeminently useful for the Operative Part. They are of two kinds, and seven in number, though I call them all by the general name of *Practical Instances*. In the Operative Part there are two defects, and two corresponding prerogatives of instances. For operation either fails us or it overtasks us. The chief cause of failure in operation (especially after natures have been diligently investigated) is the ill determination and measurement of the forces and actions of bodies. Now the forces and actions of bodies are circumscribed and measured, either by distances of space, or by moments of time, or by concentration of quantity, or by predominance of virtue; and unless these four things have been well and carefully weighed, we shall have sciences, fair perhaps in theory, but in practice inefficient. The four instances which are useful in this point of view I class under one head as *Mathematical Instances* and *Instances of Measurement.*

Operation comes to overtask us, either through the admixture of useless matters, or through the multiplicity of instruments, or through the bulk of the material and of the bodies that may happen to be required for any particular work. Those instances therefore ought to be valued, which either direct practice to the

objects most useful to mankind; or which save instruments; or which spare material and provision. The three instances which serve us here, I class together as *Propitious* or *Benevolent Instances*. These seven Instances I will now discuss separately, and with them conclude that division of my subject which relates to the Prerogatives or Rank of Instances.

XLV.

Among Prerogative Instances I will put in the twenty-first place *Instances of the Rod or Rule;* which I also call *Instances of Range* or of *Limitation*. For the powers and motions of things act and take effect at distances, not indefinite or accidental, but finite and fixed; so that to ascertain and observe these distances in the investigation of the several natures is of the greatest advantage to practice, not only to prevent its failure but also to extend and increase its power. For we are sometimes enabled to extend the range of powers, and as it were to diminish distances; as for instance by the use of telescopes.

Most of these powers act and take effect only by manifest contact; as in the impact of two bodies, where the one does not move the other from its place unless they touch each other. Also medicines that are applied externally, as ointments or plasters, do not exert their virtues without touching the body. Finally the objects of the taste and touch do not strike those senses unless they be contiguous to the organs.

There are also powers which act at a distance, though a very small one; and of these only a few have been hitherto observed, albeit there are many more than men suspect; as (to take common exam-

ples) when amber or jet attracts straws; bubbles dissolve bubbles on being brought together; certain purgative medicines draw humours downwards, and the like. So too the magnetic power by which iron and a magnet, or two magnets, are made to meet, operates within a fixed but narrow sphere of action; but if there be any magnetic virtue flowing from the earth (a little below the surface), and acting on a steel needle in respect of its polarity, the action operates at a great distance.

Again, if there be any magnetic power which operates by consent between the globe of the earth and heavy bodies, or between the globe of the moon and the waters of the sea (as seems highly probable in the semi-menstrual ebbs and floods), or between the starry sphere and the planets, whereby the latter are attracted to their apogees; all these must operate at very great distances. There are found also certain materials which catch fire a long way off; as we are told the naphtha of Babylon does. Heat also insinuates itself at great distances; as also does cold; insomuch that by the inhabitants of Canada the masses of ice that break loose and float about the northern ocean, and are borne through the Atlantic towards that coast, are perceived at a great distance by the cold they give out. Perfumes also (though in these there appears to be always a certain corporeal discharge) act at remarkable distances; as those find who sail along the coasts of Florida, or some parts of Spain, where there are whole woods of lemon and orange and like odoriferous trees, or thickets of rosemary, marjoram, and the like. Lastly the radiations of light and impressions of sound operate at vast distances.

But whether the distances at which these powers act be great or small, it is certain that they are all finite and fixed in the nature of things, so that there is a certain limit never exceeded; and a limit which depends either on the mass or quantity of matter in the bodies acted on; or on the strength or weakness of the powers acting; or on the helps or hindrances presented by the media in which they act; all which things should be observed and brought to computation. Moreover the measurements of violent motions (as they are called), as of projectiles, guns, wheels, and the like, since these also have manifestly their fixed limits, should be observed and computed.

There are found also certain motions and virtues of a contrary nature to those which operate by contact and not at a distance; namely, those which operate at a distance and not by contact; and again those which operate more feebly at a less distance, and more powerfully at a greater. The act of sight for instance is not well performed in contact, but requires a medium and a distance. Yet I remember being assured by a person of veracity that he himself under an operation for the cataract, when a small silver needle was inserted within the first coat of the eye in order to remove the pellicle of the cataract and push it into a corner, saw most distinctly the needle passing over the very pupil. But though this may be true, it is manifest that large bodies are not well or distinctly seen except at the vertex of a cone, the rays from the object converging at a certain distance from it. Moreover, old people see objects better at a little distance than if quite close. In projectiles too it is certain that the impact is not so violent at too small a distance as it is a little further off. These

therefore and like things should be observed in the measurements of motions with regard to distances.

There is also another kind of local measurement of motions which must not be omitted. This has to do with motions not progressive, but spherical; that is, with the expansion of bodies into a greater sphere or their contraction into a less. For among our measurements of motions we must inquire what degree of compression or extension bodies (according to their nature) easily and freely endure, and at what point they begin to resist, till at last they will bear no more. Thus when a blown bladder is compressed, it allows a certain compression of the air, but if the compression be increased, the air does not endure it, and the bladder bursts.

But this same thing I have tested more accurately by a subtle experiment. I took a small bell of metal, light and thin, such as is used for holding salt, and plunged it into a basin of water, so that it carried down with it the air contained in its cavity to the bottom of the basin; where I had previously placed a small globe, on which the bell was to light. I found then that if the globe was small enough in proportion to the cavity, the air contracted itself into a less space, and was simply squeezed together, not squeezed out. But if it was too large for the air to yield freely, then the air impatient of greater pressure raised the bell on one side, and rose to the surface in bubbles.

Again to test the extension, as well as compression, of which air was susceptible, I had recourse to the following device. I took a glass egg, with a small hole at one end of it, and having drawn out the air through the hole by violent suction, I immediately stopt up the

hole with my finger, and plunged the egg into water, and then took away my finger. The air having been extended by the suction and dilated beyond its natural dimensions, and therefore struggling to contract itself again (so that if the egg had not been plunged into the water, it would have drawn in air with a hissing sound), now drew in water in sufficient quantities to allow the air to recover its old sphere or dimension

Now it is certain that the rarer bodies (such as air) allow a considerable degree of contraction, as has been stated; but that tangible bodies (such as water) suffer compression with much greater difficulty, and to a less extent. How far they do suffer it, I have investigated in the following experiment. I had a hollow globe of lead made, capable of holding about two pints, and sufficiently thick to bear considerable force. Having made a hole in it, I filled it with water, and then stopt up the hole with melted lead, so that the globe became quite solid. I then flattened two opposite sides of the globe with a heavy hammer, by which the water was necessarily contracted into less space; a sphere being the figure of largest capacity. And when the hammering had no more effect in making the water shrink, I made use of a mill or press; till the water impatient of further pressure exuded through the solid lead like a fine dew. I then computed the space lost by the compression, and concluded that this was the extent of compression which the water had suffered; but only when constrained by great violence.

But the compression or extension endured by more solid, dry, or more compact bodies, such as wood, stones and metals, is still less than this, and scarcely

perceptible. For they free themselves either by breaking, or by moving forward, or by other efforts; as is apparent in the bending of wood or metal, in clocks moving by springs, in projectiles, hammerings, and numberless other motions. And all these things with their measures should in the investigation of nature be explored and set down, either in their certitude, or by estimate, or by comparison, as the case will admit.

XLVI.

Among Prerogative Instances I will put in the twenty-second place *Instances of the Course;* which I also call *Instances of the Water;* borrowing the term from the hourglasses of the ancients, which contained water instead of sand. These measure nature by periods of time, as the Instances of the Rod by degrees of space. For all motion or natural action is performed in time; some more quickly, some more slowly, but all in periods determined and fixed in the nature of things. Even those actions which seem to be performed suddenly and (as we say) in the twinkling of an eye, are found to admit of degree in respect of duration.

First then we see that the revolutions of heavenly bodies are accomplished in calculated times; as also the flux and reflux of the sea. The motion of heavy bodies to the earth, and of light bodies toward the heavens, is accomplished in definite periods, varying with the bodies moved and the medium through which they move. The sailing of ships, the movements of animals, the transmission of missiles, are all performed likewise in times which admit (in the aggregate) of measurement. As for heat, we see boys in winter

time bathe their hands in flame without being burned, and jugglers by nimble and equable movements turn vessels full of wine or water upside down and then up again, without spilling the liquid; and many other things of a similar kind. The compressions also and expansions and eruptions of bodies are performed, some more quickly, some more slowly, according to the nature of the body and motion, but in certain periods. Moreover in the explosion of several guns at once, which are heard sometimes to the distance of thirty miles, the sound is caught by those who are near the spot where the discharge is made, sooner than by those who are at a greater distance. Even in sight, whereof the action is most rapid, it appears that there are required certain moments of time for its accomplishment; as is shown by those things which by reason of the velocity of their motion cannot be seen — as when a ball is discharged from a musket. For the ball flies past in less time than the image conveyed to the sight requires to produce an impression.

This fact, with others like it, has at times suggested to me a strange doubt; viz. whether the face of a clear and starlight sky be seen at the instant at which it really exists, and not a little later; and whether there be not, as regards our sight of heavenly bodies, a real time and an apparent time, just like the real place and apparent place which is taken account of by astronomers in the correction for parallaxes. So incredible did it appear to me that the images or rays of heavenly bodies could be conveyed at once to the sight through such an immense space, and did not rather take a perceptible time in travelling to us. But this suspicion as to any considerable interval between

the real time and the apparent afterwards vanished entirely, when I came to think of the infinite loss and diminution of quantity which distance causes in appearance between the real body of the star and its seen image; and at the same time when I observed the great distance (sixty miles at the least) at which bodies merely white are instantly seen here on earth; while there is no doubt that the light of heavenly bodies exceeds many times over in force of radiation, not merely the vivid colour of whiteness, but also the light of every flame that is known to us. Again the immense velocity in the body itself as discerned in its daily motion (which has so astonished certain grave men that they preferred believing that the earth moved) renders this motion of ejaculation of rays therefrom (although wonderful, as I have said, in speed) more easy of belief. But what had most weight of all with me was, that if any perceptible interval of time were interposed between the reality and the sight, it would follow that the images would oftentimes be intercepted and confused by clouds rising in the meanwhile, and similar disturbances in the medium. And thus much for the simple measures of time.

But not only must we seek the measure of motions and actions by themselves, but much more in comparison; for this is of excellent use and very general application. Now we find that the flash of a gun is seen sooner than its report is heard; although the ball must necessarily strike the air before the flame behind it can get out; and this is owing it seems to the motion of light being more rapid than that of sound. We find too that visible images are received by the sight faster than they are dismissed; thus the strings of a violin,

when struck by the finger, are to appearance doubled or tripled, because a new image is received before the old one is gone; which is also the reason why rings being spun round look like globes, and a lighted torch, carried hastily at night, seems to have a tail. And it was upon this inequality of motions in point of velocity that Galileo built his theory of the flux and reflux of the sea; supposing that the earth revolved faster than the water could follow; and that the water therefore first gathered in a heap and then fell down, as we see it do in a basin of water moved quickly. But this he devised upon an assumption which cannot be allowed, viz. that the earth moves; and also without being well informed as to the sexhorary motion of the tide.

But an example of the thing I am treating of, to wit, the comparative measures of motions,— and not only of the thing itself, but also of its eminent use (of which I spoke just now),— is conspicuous in mining with gunpowder; where vast masses of earth, buildings, and the like are upset and thrown into the air by a very small quantity of powder. The cause of which is doubtless this; that the motion of expansion in the impelling powder is quicker many times over than the motion of the resisting gravity; so that the first motion is over before the counter motion is begun, and thus at first the resistance amounts to nothing. Hence too it happens that in projectiles it is not the strong blow, but the sharp and quick, that carries the body furthest. Nor would it be possible for the small quantity of animal spirit in animals, especially in such huge creatures as the whale or elephant, to bend and guide such a vast mass of body, were it not for the velocity of the spirit's motion, and the slowness of the bodily mass in exerting its resistance.

This one thing indeed is a principal foundation of the experiments in natural magic, of which I shall speak presently; wherein a small mass of matter overcomes and regulates a far larger mass; I mean the contriving that of two motions one shall by its superior velocity get the start and take effect before the other has time to act.

Lastly, this distinction of foremost and hindmost ought to be observed in every natural action. Thus in an infusion of rhubarb the purgative virtue is extracted first, the astringent afterwards. And something of the kind I have found on steeping violets in vinegar, where the sweet and delicate scent of the flower is extracted first, and then the more earthy part of the flower, which mars the scent. Therefore, if violets be steeped in vinegar for a whole day, the scent is extracted much more feebly; but if you keep them in for a quarter of an hour only and then take them out, and (since the scented spirit in violets is small) put in fresh violets every quarter of an hour as many as six times, the infusion is at last so enriched that although there have not been violets in the vinegar, however renewed, for more than an hour and a half altogether, there nevertheless remains in it a most grateful odour, as strong as the violet itself, for an entire year. It should be observed however that the odour does not gather its full strength, till after a month from the time of infusion. In the distillation too of aromatic herbs crushed in spirit of wine, it appears that there first rises an aqueous and useless phlegm; then a water containing more of the spirit of wine; and lastly, a water containing more of the aroma. And of this kind there are to be found in

distillations a great many facts worthy of notice. But let these suffice for examples.

XLVII.

Among Prerogative Instances I will put in the twenty-third place *Instances of Quantity;* which (borrowing a term from medicine) I also call *Doses of Nature.* These are they which measure virtues according to the *quantity* of the bodies in which they subsist, and show how far the *mode* of the virtue depends upon the *quantity* of the body. And first there are certain virtues, which subsist only in a cosmical quantity; that is, such a quantity as has consent with the configuration and fabric of the universe. The earth for instance stands fast; its parts fall. The waters in seas ebb and flow; but not in rivers, except through the sea coming up. Secondly, almost all particular virtues act according to the greater or less quantity of the body. Large quantities of water corrupt slowly, small ones quickly. Wine and beer ripen and become fit to drink much more quickly in bottles than in casks. If an herb be steeped in a large quantity of liquid, infusion takes place rather than impregnation; if in a small, impregnation rather than infusion. Thus in its effect on the human body a bath is one thing, a slight sprinkling another. Light dews again never fall in the air, but are dispersed and incorporated with it. And in breathing on precious stones you may see the slight moisture instantly dissolved, like a cloud scattered by the wind. Once more, a piece of a magnet does not draw so much iron as the whole magnet. On the other hand there are virtues in which smallness of quantity has more effect; as in piercing, a sharp point pierces more quickly

than a blunt one; a pointed diamond cuts glass, and the like.

But we must not stay here among indefinites, but proceed to inquire what *proportion* the Quantity of a Body bears to the Mode of its Virtue. For it would be natural to believe that the one was equal to the other; so that if a bullet of an ounce weight falls to the ground in a given time, a bullet of two ounces ought to fall twice as quickly; which is not the fact. Nor do the same proportions hold in all kinds of virtues, but widely different. These measures therefore must be sought from experiment, and not from likelihood or conjecture.

Lastly, in all investigation of nature the quantity of body — the Dose, as it were — required to produce any effect must be set down; and cautions as to the Too Little and Too Much be interspersed.

XLVIII.

Among Prerogative Instances I will put in the twenty-fourth place *Instances of Strife;* which I also call *Instances of Predominance.* These indicate the mutual predominance and subjection of virtues; which of them is stronger and prevails, which of them is weaker and gives way. For the motions and efforts of bodies are compounded, decomposed, and complicated, no less than the bodies themselves. I will therefore first propound the principal kinds of motions or active virtues; in order that we may be able more clearly to compare them together in point of strength, and thereby to point out and designate more clearly the Instances of Strife and Predominance.

Let the First Motion be that motion of *Resistance* in

matter which is inherent in each several portion of it, and in virtue of which it absolutely refuses to be annihilated; so that no fire, no weight or pressure, no violence, no length of time can reduce any portion of matter, be it ever so small, to nothing; but it will ever be something, and occupy some space; and, to whatever straits it may be brought, will free itself by changing either its form or its place; or if this may not be, will subsist as it is; and will never come to such a pass as to be either nothing or nowhere. This motion the Schoolmen (who almost always name and define things rather by effects and incapacities than by inner causes) either denote by the axiom "Two bodies cannot be in one place," or call "The motion to prevent penetration of dimensions." Of this motion it is unnecessary to give examples, as it is inherent in every body.

Let the Second Motion be what I call Motion of *Connexion;* by which bodies do not suffer themselves to be separated at any point from contact with another body; as delighting in mutual connexion and contact. This motion the Schoolmen call "Motion to prevent a vacuum," as when water is drawn up by suction or in a pump; the flesh by cupping-glasses; or when water stops without running out in perforated jars, unless the mouth of the jar be opened to let in the air; and in numberless instances of a similar kind.

Let the Third Motion be what I call Motion of *Liberty;* by which bodies strive to escape from preternatural pressure or tension, and to restore themselves to the dimensions suitable to their nature. Of this motion also we have innumerable examples; such as (to speak first of escape from pressure) the motion of water in swimming, of air in flying, of water in row-

ing, of air in the undulations of winds, of a spring in clocks; of which we have also a pretty instance in the motion of the air compressed in children's popguns, when they hollow out an alder twig or some such thing, and stuff it up at both ends with a piece of pulpy root or the like, and then with a ramrod thrust one of the roots or whatever the stuffing be towards the other hole, from which the root at the further end is discharged with a report; and that before it is touched by the nearer root or the ramrod. As for bodies escaping from tension, this motion displays itself in air remaining in glass eggs after suction; in strings, in leather and in cloth, which recoil after tension, unless it has gained too great strength by continuance; and in similar phenomena. This motion the Schoolmen refer to under the name of "Motion in accordance with the form of the Element;" an injudicious name enough, since it is a motion which belongs not only to fire, air and water, but to every variety of solid substance, as wood, iron, lead, cloth, parchment, &c.; each of which bodies has its own proper limit of dimension, out of which it cannot easily be drawn to any considerable extent. But since this Motion of Liberty is of all the most obvious, and is of infinite application, it would be a wise thing to distinguish it well and clearly. For some very carelessly confuse this motion with the two former motions of Resistance and Connexion; the motion, that is, of escape from pressure with the Motion of Resistance; of escape from tension with the Motion of Connexion; just as if bodies when compressed yield or expand, that there may not ensue penetration of dimensions; and, when stretched, recoil and contract, that there may not ensue a vacuum.

Whereas if air when compressed had a mind to contract itself to the density of water, or wood to the density of stone, there would be no necessity for penetration of dimensions; yet there might be a far greater compression of these bodies, than they ever do actually sustain. In the same way, if water had a mind to expand to the rarity of air, or stone to the rarity of wood, there would be no need for a vacuum to ensue; and yet there might be effected a far greater extension of these bodies than they ever do actually sustain. Thus the matter is never brought to a penetration of dimensions or to a vacuum, except in the extreme limits of condensation and rarefaction; whereas the motions of which I speak stop far short of these limits, and are nothing more than desires which bodies have for preserving themselves in their consistencies (or, if the Schoolmen like, in their forms), and not suddenly departing therefrom, unless they be altered by gentle means, and with consent. But it is far more necessary (because much depends upon it) that men should know, that violent motion (which we call Mechanical, but which Democritus, who in expounding his primary motions is to be ranked even below second rate philosophers, called Motion of Stripe) is nothing more than this Motion of Liberty, that is, of escape from compression to relaxation. For either in a mere thrust, or in flight through the air, there occurs no movement or change of place, until the parts of the body moved are acted upon and compressed by the impelling body more than their nature will bear. Then indeed, when each part pushes against the next, one after the other, the whole is moved; and it not only moves forward, but revolves at the same time; the parts seeking in

that way also to free themselves or to distribute the pressure more equally. And so much for this Motion.

Let the Fourth Motion be that to which I have given the name of the Motion of *Matter;* which is in some sort the converse of the last named motion. For in the Motion of Liberty bodies dread, loathe, and shun a new dimension, or a new sphere, or new expansion or contraction (which are all names for the same thing), and strive with all their might to recoil, and recover their old consistency. On the contrary in this Motion of Matter, bodies desire a new sphere or dimension, and aspire thereto readily and quickly, and sometimes, as in the case of gunpowder, with most violent effort. Now the instruments of this motion, not indeed the sole, but the most potent, or at any rate the most common, are heat and cold. For instance; air, if expanded by tension, as by suction in glass eggs, labours under a strong desire to recover itself. But if heat be applied, it longs on the contrary to expand, and desires a new sphere, and passes into it readily, as into a new form (so they phrase it); and after a certain degree of expansion cares not to return, unless invited thereto by the application of cold; which is not a return, but a renewed transmutation. In the same way water, if made to contract by pressure, resists and wishes to become such as it was, that is, larger. But if there intervene intense and continued cold, it changes itself spontaneously and gladly to the density of ice; and if the cold be continued long, without interruption from heat, as in grottoes and caverns of some depth, it turns to crystal or some similar material, and never recovers its form.

Let the Fifth Motion be the Motion of *Continuity;*

by which I do not mean simple and primary continuity with some other body (for that is the Motion of Connexion), but self-continuity in a given body. For it is most certain that all bodies dread a solution of continuity; some more, some less, but all to a certain extent. For while in hard bodies, as steel or glass, the resistance to discontinuity is exceedingly strong; even in liquids, where it seems to disappear, or at all events to be very feeble, it is not altogether absent, but is certainly there, though in its lowest degree of power, and betrays itself in very many experiments; as in bubbles, in the roundness of drops, in the thin threads of droppings from roofs, in the tenacity of glutinous bodies, and the like. But most of all does this appetite display itself, if an attempt be made to extend the discontinuity to minute fragments. For in a mortar, after a certain amount of pulverisation, the pestle produces no further effect; water does not penetrate into minute chinks; even air itself, notwithstanding its subtlety, does not suddenly pass through the pores of solid vessels, but only after long insinuation.

Let the Sixth Motion be that which I call Motion *for Gain*, or Motion *of Want*. It is that by which bodies, when placed among quite heterogeneous and hostile bodies, if they find an opportunity of escaping from these and uniting themselves to others more cognate, (though these others be such as have no close union with them,) do nevertheless embrace the latter and choose them as preferable; and seem to view this connexion in the light of a *gain* (whence the term), as though they stood in need of such bodies. For instance, gold or any other metal in the leaf does not like the surrounding air. If therefore it meet with any

thick tangible body, (as a finger, paper, what you will,) it instantly sticks to it and is not easily torn away. So too paper, cloth, and the like do not agree well with the air which is lodged in their pores. They are therefore glad to imbibe water or other moisture and eject the air. A piece of sugar too, or a sponge, if dipped at one end in water or wine, while the other stands out far above the surface, draws the water or the wine gradually upwards.

Hence we derive an excellent rule for opening and dissolving bodies. For (to say nothing of corrosives and strong waters which open for themselves a way) if there can be found a body proportioned to and more in harmony and affinity with a given solid body, than that with which it is, as of necessity, mixed, the solid body immediately opens and relaxes itself, and shutting out or ejecting the latter, receives the former into itself. Nor does this Motion for Gain act or exist only in immediate contact. For electricity (of which Gilbert and others after him have devised such stories) is nothing else than the appetite of a body when excited by gentle friction — an appetite which does not well endure the air, but prefers some other tangible body, if it be found near at hand.

Let the Seventh Motion be what I call the Motion *of the Greater Congregation;* by which bodies are carried towards masses of a like nature with themselves; heavy bodies to the globe of the earth, light to the compass of the heaven. This the Schoolmen have denoted by the name of *Natural Motion;* from superficial considerations; either because there was nothing conspicuous externally which could produce such motion (and therefore they supposed it to be innate and inherent in

things themselves); or perhaps because it never ceases. And no wonder; for the earth and heaven are ever there, whereas the causes and origins of most other motions are sometimes absent, sometimes present. Accordingly this motion, because it ceases not, but when others cease is felt instantly, they deem perpetual and proper; all others adscititious. This motion however in point of fact is sufficiently weak and dull, being one which, except in bodies of considerable bulk, yields and succumbs to all other motions, as long as they are in operation. And though this motion has so filled men's thoughts as to have put all others almost out of sight, yet it is but little that they know about it, being involved in many errors with regard to it.

Let the Eighth Motion be the Motion of *the Lesser Congregation;* by which the homogeneous parts in a body separate themselves from the heterogeneous, and combine together; by which also entire bodies from similarity of substance embrace and cherish each other, and sometimes are attracted and collected together from a considerable distance; as when in milk, after it has stood awhile, the cream rises to the top; while in wine the dregs sink to the bottom. For this is not caused by the motion of heaviness and lightness only, whereby some parts rise up and some sink down; but much more by a desire of the homogeneous parts to come together and unite in one. Now this motion differs from the Motion of Want in two points. One is that in the latter there is the stronger stimulus of a malignant and contrary nature; whereas in this motion (provided there be nothing to hinder or fetter it) the parts unite from friendship, even in the absence of a foreign nature to stir up strife. The other point

is, that the union is here closer, and as it were with greater choice. In the former, if only the hostile body be avoided, bodies not closely related come together; whereas in the latter, substances are drawn together by the tie of close relationship, and as it were combine into one. And this motion resides in all composite bodies, and would readily show itself were it not bound and restrained by other appetites and necessities in the bodies, which interfere with the union in question.

Now the binding of this motion takes place generally in three ways; by the torpor of bodies; by the check of a dominant body; and by external motions. Now, for the torpor of bodies, it is certain that there resides in tangible substances a certain sluggishness, more or less, and an aversion from change of place; insomuch that, unless they be excited, they had rather remain as they are than change for the better. Now this torpor is shaken off by the help of three things; either by heat, or by the eminent virtue of some cognate body, or by lively and powerful motion. And as for the help of heat, it is for this reason that heat has been defined to be "that which separates Heterogeneous and congregates Homogeneous parts;" a definition of the Peripatetics justly derided by Gilbert, who says it is much the same as if a man were to be defined as that which sows wheat and plants vines — for that it is a definition simply by effects, and those particular. But the definition has a worse fault; inasmuch as these effects, such as they are, arise not from a peculiar property of heat, but only indirectly (for cold does the same, as I shall afterwards show); being caused by the desire of homogeneous parts to unite; heat simply aiding to shake off the torpor which had previously bound

the desire. As for the help derived from the virtue of a cognate body, it is well seen in an armed magnet, which excites in iron the virtue of detaining iron by similarity of substance; the torpor of the iron being cast off by the virtue of the magnet. And as for help derived from motion, it is shown in wooden arrows, having their points also of wood, which penetrate more deeply into wood than if they were tipped with steel, owing to the similarity of substance; the torpor of the wood being shaken off by the rapid motion. Of these two experiments I have spoken also in the Aphorism on Clandestine Instances.

That binding of the motion of the Lesser Congregation which is caused by the restraint of a dominant body, is seen in the resolution of blood and urine by cold. For as long as those bodies are filled with the active spirit, which, as lord of the whole, orders and restrains the several parts of whatsoever sort, so long the homogeneous parts do not meet together on account of the restraint; but as soon as the spirit has evaporated, or been choked by cold, then the parts being freed from restraint meet together in accordance with their natural desire. And thus it happens that all bodies which contain an eager spirit (as salts and the like) remain as they are, and are not resolved; owing to the permanent and durable restraint of a dominant and commanding spirit.

That binding of the motion of Lesser Congregation which is caused by external motion, is most conspicuous in the shaking of bodies to prevent putrefaction. For all putrefaction depends on the assembling together of homogeneous parts; whence there gradually ensues the corruption of the old form, as they call it,

and the generation of a new. For putrefaction, which paves the way for the generation of a new form, is preceded by a dissolution of the old; which is itself a meeting together of homogeneous parts. That indeed, if not impeded, is simple resolution; but if it be met by various obstacles, there follow putrefactions, which are the rudiments of a new generation. But if (which is the present question) a frequent agitation be kept up by external motion, then indeed this motion of uniting (which is a delicate and tender one, and requires rest from things without) is disturbed and ceases; as we see happen in numberless instances. For example, the daily stirring or flowing of water prevents it from putrefying; winds keep off pestilence in the air; corn turned and shaken in the granary remains pure; all things in short that are shaken outwardly are the slower to putrefy inwardly.

Lastly, I must not omit that meeting of the parts of bodies, which is the chief cause of induration and desiccation. For when the spirit, or moisture turned to spirit, has escaped from some porous body (as wood, bone, parchment, and the like), then the grosser parts are with stronger effort drawn and collected together; whence ensues induration or desiccation; which I take to be owing not so much to the Motion of Connexion, to prevent a vacuum, as to this motion of friendship and union.

As for the meeting of bodies from a distance, that is a rare occurrence, and yet it exists in more cases than are generally observed. We have illustrations of it when bubble dissolves bubble; when medicines draw humours by similarity of substance; when the chord of one violin makes the chord of another sound an

unison, and the like. I suspect also that this motion prevails in the spirits of animals, though it be altogether unknown. At any rate it exists conspicuously in the magnet and magnetised iron. And now that we are speaking of the motions of the magnet, they ought to be carefully distinguished. For there are four virtues or operations in the magnet, which should not be confounded but kept apart; although the wonder and admiration of men have mixed them up together. The first is, the attraction of magnet to magnet, or of iron to magnet, or of magnetised iron to iron. The second is its polarity, and at the same time its declination. The third, its power of penetrating through gold, glass, stone, everything. The fourth, its power of communicating its virtue from stone to iron, and from iron to iron, without communication of substance. In this place however I am speaking only of the first of these virtues—that is, its attractive power. Remarkable also is the motion of attraction between quicksilver and gold; insomuch that gold attracts quicksilver, though made up into ointments; and men who work amid the vapours of quicksilver usually hold a piece of gold in their mouths, to collect the exhalations which would otherwise penetrate into their skulls and bones; by which also the piece of gold is presently turned white. And so much for the motion of the Lesser Congregation.

Let the Ninth Motion be the *Magnetic;* which, though it be of the same genus with the Motion of the Lesser Congregation, yet if it operates at great distances and on large masses, deserves a separate investigation; especially if it begin not with contact, as most, nor lead to contact, as all motions of congrega-

tion do; but simply raise bodies or make them swell, and nothing more. For if the moon raises the waters, or makes moist things swell; if the starry heaven attracts planets to their apogees; if the sun holds Venus and Mercury so that their elongations never exceed a certain distance; these motions seem to fall properly neither under the Greater nor the Lesser Congregation, but to be of a sort of intermediate and imperfect Congregation, and therefore ought to constitute a species by themselves.

Let the Tenth Motion be that of *Flight;* a motion the exact opposite of that of the Lesser Congregation; by which bodies from antipathy flee from and put to flight hostile bodies, and separate themselves from them, or refuse to mingle with them. For although in some cases this motion may seem to be an accident or a consequence of the motion of the lesser congregation, because the homogeneous parts cannot meet without dislodging and ejecting the heterogeneous, still it is a motion that should be classed by itself, and formed into a distinct species, because in many cases the appetite of Flight is seen to be more dominant than the appetite of Union.

This motion is eminently conspicuous in the excretions of animals; and not less in objects odious to some of the senses, especially the smell and the taste. For a fetid odour is so rejected by the sense of smell as to induce by consent in the mouth of the stomach a motion of expulsion; a rough and bitter taste is so rejected by the palate or throat as to induce by consent a shaking of the head and a shudder. But this motion has place in other things also. It is observed in certain forms of reaction; as in the middle region of the

air, where the cold seems to be the effect of the rejection of the nature of cold from the confines of the heavenly bodies; as also the great heats and burnings which are found in subterranean places, appear to be rejections of the nature of heat from the inner parts of the earth. For heat and cold, in small quantities, kill one another; but if they be in large masses, and as it were in regular armies, the result of the conflict is that they displace and eject each other in turn. It is also said that cinnamon and other perfumes retain their scent longer when placed near sinks and foul-smelling places, because they refuse to come out and mingle with stenches. It is certain that quicksilver, which of itself would reunite into an entire mass, is kept from doing so by spittle, hog's lard, turpentine, and the like; owing to the ill consent which its parts have with such bodies, from which when spread around them they draw back; so that their desire to fly from these intervening bodies is more powerful than their desire of uniting with parts like themselves. And this is called the *mortification* of quicksilver. The fact also that oil does not mix with water is not simply owing to the difference of weight, but to the ill consent of these fluids; as may be seen from the fact that spirit of wine, though lighter than oil, yet mixes well enough with water. But most of all is the Motion of Flight conspicuous in nitre and such like crude bodies, which abhor flame; as in gunpowder, quicksilver, and gold. But the flight of iron from one pole of the magnet is well observed by Gilbert to be not a Flight strictly speaking, but a conformity and meeting in a more convenient situation.

Let the Eleventh Motion be that of *Assimilation*, or

of *Self-Multiplication*, or again of simple *Generation*. By which I mean not the generation of integral bodies, as plants or animals, but of bodies of uniform texture. That is to say, by this motion such bodies convert others which are related, or at any rate well disposed to them, into their own substance and nature. Thus flame over vapours and oily substances multiplies itself and generates new flame; air over water and watery substances multiplies itself and generates new air; spirit, vegetable and animal, over the finer parts as well of watery as of oily substance in its food, multiplies itself and generates new spirit; the solid parts of plants and animals, as the leaf, flower, flesh, bone, and the like, severally assimilate new substance to follow and supply what is lost out of the juices of their food. For let no one adopt the wild fancy of Paracelsus, who (blinded I suppose by his distillations) will have it that nutrition is caused only by separation; and that in bread and meat lie eye, nose, brain, liver; in the moisture of the ground, root, leaf, and flower. For as the artist out of the rude mass of stone or wood educes, by separation and rejection of what is superfluous, leaf, flower, eye, nose, hand, foot, and the like; so, he maintains, does Archæus, the internal artist, educe out of food by separation and rejection the several members and part of our body. But to leave such trifles, it is most certain that the several parts, as well similar as organic, in vegetables and animals do first attract with some degree of selection the juices of their food, which are alike or nearly so for all, and then assimilate them and turn them into their own nature. Nor does this Assimilation or simple Generation take place only in animate bodies, but inanimate

also participate therein, as has been stated of flame and air. Moreover the non-vital spirit, which is contained in every tangible animated substance, is constantly at work to digest the coarser parts and turn them into spirit, to be afterwards discharged; whence ensues diminution of weight and desiccation, as I have stated elsewhere. Nor must we set apart from Assimilation that accretion which is commonly distinguished from alimentation; as when clay between stones concretes and turns into a stony substance, or the scaly substance on the teeth turns into a substance as hard as the teeth themselves, and so on. For I am of opinion that there resides in all bodies a desire for Assimilation, as well as for uniting with homogeneous substances; but this virtue is bound, as is the other, though not by the same means. But these means, as well as the way of escape from them, ought to be investigated with all diligence, because they pertain to the rekindling of the vital power in old age. Lastly, it seems worthy of observation that in the nine motions of which I have spoken bodies seem to desire only the preservation of their nature, but in this tenth the propagation of it.

Let the Twelfth Motion be that of *Excitation;* a motion which seems to belong to the genus of Assimilation, and which I sometimes call by that name. For it is a motion diffusive, communicative, transitive, and multiplicative, as is the other; and agreeing with it generally in effect, though differing in the mode of effecting and in the subject matter. For the Motion of Assimilation proceeds as it were with authority and command; it orders and forces the assimilated body to turn into the assimilating. But the Motion of Excita-

tion proceeds, so to speak, with art and by insinuation, and stealthily; simply inviting and disposing the excited body to the nature of the exciting. Again, the Motion of Assimilation multiplies and transforms bodies and substances; thus, more flame is produced, more air, more spirit, more flesh. But in the Motion of Excitation, virtues only are multiplied and transferred; more heat being engendered, more magnetic power, more putrefying. This motion is particularly conspicuous in heat and cold. For heat does not diffuse itself, in heating a body, by communication of the original heat, but simply by exciting the parts of the body to that motion which is the Form of Heat; of which I have spoken in the First Vintage concerning the Nature of Heat. Consequently heat is excited far more slowly and with far greater difficulty in stone or metal than in air, owing to the unfitness and unreadiness of those bodies to receive the motion; so that it is probable that there may exist materials in the bowels of the earth which altogether refuse to be heated, because through their greater condensation they are destitute of that spirit with which this Motion of Excitation generally begins. In like manner the magnet endues iron with a new disposition of its parts and a conformable motion, but loses nothing of its own virtue. Similarly leaven, yeast, curd, and certain poisons excite and invite a successive and continued motion in dough, beer, cheese, or the human body, not so much by the force of the exciting as by the predisposition and easy yielding of the excited body.

Let the Thirteenth Motion be the Motion of *Impression;* which also is of the same genus with the Motion of Assimilation, and is of diffusive motions the most

subtle. I have thought fit however to make a distinct species of it, on account of a remarkable difference between it and the two former. For the simple Motion of Assimilation actually transforms the bodies themselves; so that you may take away the first mover, and there will be no difference in what follows. For the first kindling into flame, or the first turning into air, has no effect on the flame or air next generated. In like manner, the Motion of Excitation continues, after the first mover is withdrawn, for a very considerable time; as in a heated body, when the primary heat has been removed; in magnetised iron, when the magnet has been put away; in dough, when the leaven has been taken out. But the Motion of Impression, though diffusive and transitive, seems to depend for ever on the prime mover; so that if that be taken away or cease to act, it immediately fails and comes to an end; and therefore the effect must be produced in a moment, or at any rate in a very brief space of time. The Motions therefore of Assimilation and Excitation I call Motions of the *Generation of Jupiter*, because the generation continues; but this, the Motion of the *Generation of Saturn*, because the birth is immediately devoured and absorbed. It manifests itself in three things; in rays of light, in the percussions of sounds, and in magnetism, as regards the communication of the influence. For if you take away light, colours and its other images instantly disappear; if you take away the original percussion and the vibration of the body thence produced, the sound soon after dies away. For though sounds are troubled as they pass through their medium by winds, as if by waves, yet it must be carefully noted that the original sound does not last all the time the

resonance goes on. For if you strike a bell, the sound seems to be continued for a good long time; whereby we might easily be led into the error of supposing that during the whole of the time the sound is as it were floating and hanging in the air; which is quite untrue. For the resonance is not the same identical sound, but a renewal of it; as is shown by quieting or stopping the body struck. For if the bell be held tight so that it cannot move, the sound at once comes to an end, and resounds no more; as in stringed instruments, if after the first percussion the string be touched, either with the finger, as in the harp, or with the quill, as in the spinnet, the resonance immediately ceases. Again, when the magnet is removed, the iron immediately drops. The moon indeed cannot be removed from the sea, nor the earth from the falling body, and therefore we can try no experiment in these cases; but the principle is the same.

Let the Fourteenth Motion be the Motion of *Configuration* or *Position;* by which bodies seem to desire not union or separation, but position, collocation, and configuration with respect to others. This motion is a very abstruse one, and has not been well investigated. In some cases indeed it seems to be without a cause, though not, I believe, really so. For if it be asked, why the heavens revolve rather from east to west than from west to east; or why they turn on poles placed near the Bears, rather than about Orion, or in any other part of heaven; such questions seem to border on insanity, since these phenomena ought rather to be received as results of observation, and merely positive facts. But though there are no doubt in nature certain things ultimate and without cause, this does not

appear to me to be one of them, being caused in my opinion by a certain harmony and consent of the universe, which has not yet fallen under observation. And if we admit the motion of the earth from west to east, the same questions remain. For it also moves on certain poles. And why, it might be asked, should these poles be placed where they are, rather than anywhere else? Again the polarity, direction, and declination of the magnet are referable to this motion. There are also found in bodies as well natural as artificial, especially in solids, a certain collocation and position of parts, and a kind of threads and fibres, which ought to be carefully investigated; since, until they are understood, these bodies cannot be conveniently managed or controlled. But those eddyings in fluids, by which when pressed, before they can free themselves, they relieve each other, that they may all have a fair share of the pressure, belong more properly to the Motion of Liberty.

Let the Fifteenth Motion be the Motion of *Transition*, or Motion *according to the Passages;* by which the virtues of bodies are more or less impeded or promoted by their media, according to the nature of the body and of the acting virtues, and also of the medium. For one medium suits light, another sound, another heat and cold, another magnetic virtues, and so on.

Let the Sixteenth Motion be the *Royal* (as I call it) or *Political* Motion; by which the predominant and commanding parts in any body curb, tame, subdue, and regulate the other parts, and compel them to unite, separate, stand still, move, and range themselves, not in accordance with their own desires, but as may conduce to the well being of the commanding part; so that

there is a sort of Government and Polity exerted by the ruling over the subject parts. This motion is eminently conspicuous in the spirits of animals, where, as long as it is in vigour, it tempers all the motions of the other parts. It is found however in other bodies in a lower degree; as I said of blood and urine, which are not decomposed till the spirit, which mixes and keeps together their parts, be discharged or quenched. Nor is this motion confined to spirits, though in most bodies the spirits are masters owing to their rapid and penetrating motion. But in bodies of greater density, and not filled with a lively and quickening spirit (such as there is in quicksilver and vitriol), the thicker parts are the masters; so that unless this yoke and restraint be by some expedient shaken off, there is very little hope of any new transformation of such bodies. But let no one suppose that I am forgetful of the point at issue, because while this series and distribution of motions tends to nothing else but the better investigation of their Predominancy by Instances of Strife, I now make mention of Predominancy among the motions themselves. For in describing this Royal Motion, I am not treating of the Predominancy of motions or virtues, but of the Predominancy of parts in bodies; such being the Predominancy which constitutes the peculiar species of motion in question.

Let the Seventeenth Motion be the *Spontaneous Motion of Rotation*, by which bodies delighting in motion and favourably placed for it enjoy their own nature, and follow themselves, not another body; and court (so to speak) their own embraces. For bodies seem either to move without limit, or to remain altogether at rest, or to tend to a limit, at which according to their

nature they either revolve or rest. Those which are favourably placed, if they delight in motion, move in a circle; with a motion, that is, eternal and infinite. Those which are favourably placed, and abhor motion, remain at rest. Those which are not favourably placed move in a right line (as the shortest path) to consort with bodies of their own nature. But this Motion of Rotation admits of nine differences; regarding, 1. the centre round which the bodies move; 2. the poles on which they move; 3. their circumference or orbit, according to their distance from the centre; 4. their velocity, according to the greater or less rapidity of their rotation; 5. the course of their motion, as from east to west, or from west to east; 6. their declination from a perfect circle by spiral lines more or less distant from their centre; 7. their declination from a perfect circle by spiral lines more or less distant from their poles; 8. the greater or less distance of these spirals from each other; 9. and lastly, the variation of the poles themselves, if they be movable; which however has nothing to do with rotation, unless it be circular. This motion in common and long received opinion is looked upon as the proper motion of heavenly bodies; though there is a grave dispute with regard to it among some both of the ancients and of the moderns, who have attributed rotation to the earth. But a juster question perhaps arises upon this (if it be not past question), namely, whether this motion (admitting that the earth stands still) is confined to the heavens, and does not rather descend and communicate itself to the air and waters. The Motion of Rotation in missiles, as in darts, arrows, musket-balls, and the like, I refer to the Motion of Liberty.

Let the Eighteenth Motion be the Motion of *Trepidation*, to which, as understood by astronomers, I do not attach much credit. But in searching carefully everywhere for the appetites of natural bodies, this motion comes before us, and ought, it seems, to constitute a species by itself. It is a motion of what may be called perpetual captivity, and occurs when bodies that have not quite found their right place, and yet are not altogether uneasy, keep for ever trembling and stirring themselves restlessly, neither content as they are nor daring to advance further. Such a motion is found in the heart and pulses of animals, and must of necessity occur in all bodies which so exist in a mean state betwéen conveniences and inconveniences, that when disturbed they strive to free themselves, and being again repulsed, are yet for ever trying again.

Let the Nineteenth and last Motion be one, which, though it hardly answers to the name, is yet indisputably a motion; and let us call it the Motion of *Repose*, or of *Aversion to Move*. It is by this motion that the earth stands still in its mass, while its extremities are moving toward the middle; not to an imaginary centre, but to union. By this appetite also all bodies of considerable density abhor motion; indeed the desire of not moving is the only appetite they have; and though in countless ways they be enticed and challenged to motion, they yet, as far as they can, maintain their proper nature. And if compelled to move, they nevertheless seem always intent on recovering their state of rest, and moving no more. While thus engaged indeed they show themselves active, and struggle for it with agility and swiftness enough, as weary and impatient of all delay. Of this appetite but a partial

representation can be seen; since here with us, from the subduing and concocting power of the heavenly bodies, all tangible substances are not only not condensed to their utmost, but are even mixed with some portion of spirit.

Thus then have I set forth the species or simple elements of motions, appetites, and active virtues, which are in nature most general. And under these heads no small portion of natural science is sketched out. I do not however mean to say that other species may not be added, or that the divisions I have made may not be drawn more accurately according to the true veins of nature, or reduced to a smaller number. Observe nevertheless that I am not here speaking of any abstract divisions; as if one were to say that bodies desire either the exaltation or the propagation or the fruition of their nature; or again, that the motions of things tend to the preservation and good either of the universe, as Resistance and Connexion; or of great wholes, as the Motions of the Greater Congregation, Rotation, and Aversion to Move; or of special forms, as the rest. For though these assertions be true, yet unless they be defined by true lines in matter and the fabric of nature, they are speculative and of little use. Meanwhile these will suffice, and be of good service in weighing the Predominancies of Virtues and finding out Instances of Strife; which is our present object.

For of the motions I have set forth some are quite invincible; some are stronger than others, fettering, curbing, arranging them; some carry farther than others; some outstrip others in speed; some cherish, strengthen, enlarge, and accelerate others.

The Motion of Resistance is altogether adamantine

and invincible. Whether the Motion of Connexion be so, I am still undecided. For I am not prepared to say for certain whether or no there be a vacuum, either collected in one place or interspersed in the pores of bodies. But of one thing I am satisfied, that the reason for which a vacuum was introduced by Leucippus and Democritus (namely, that without it the same bodies could not embrace and fill sometimes larger and sometimes smaller spaces) is a false one. For matter is clearly capable of folding and unfolding itself in space, within certain limits, without the interposition of a vacuum; nor is there in air two thousand times as much of vacuity as there is in gold; which on their hypothesis there should be. Of this I am sufficiently convinced by the potency of the virtues of pneumatical bodies (which otherwise would be floating in empty space like fine dust) and by many other proofs. As for the other motions, they rule and are ruled in turn, in proportion to their vigour, quantity, velocity, force of projection, and also to the helps and hindrances they meet with.

For instance, there are some armed magnets that hold and suspend iron of sixty times their own weight; so far does the motion of the Lesser prevail over the motion of the Greater Congregation; but if the weight be increased, it is overcome. A lever of given strength will raise a given weight; so far does the Motion of Liberty prevail over that of the Greater Congregation; but if the weight be increased, it is overcome. Leather stretches to a certain extent without breaking; so far does the Motion of Continuity prevail over the Motion of Tension; but if the tension be increased, the leather breaks, and the Motion of Continuity is overcome.

Water runs out at a crack of a certain size; so far does the motion of the Greater Congregation prevail over the Motion of Continuity; but if the crack be smaller, it gives way, and the Motion of Continuity prevails. If you charge a gun with ball and sulphur only, and apply the match, the ball is not discharged; the Motion of the Greater Congregation overcoming in this case the Motion of Matter. But if you charge with gunpowder, the Motion of Matter in the sulphur prevails, being aided by the Motions of Matter and of Flight in the nitre. And so of other cases. Instances of Strife, therefore, which point out the Predominancies of Virtues, together with the manner and proportion in which they predominate or give place, should be sought and collected from all quarters with keen and careful diligence.

Nor should we examine less carefully the modes in which these motions give way. That is to say, whether they stop altogether, or whether they continue to resist, but are overpowered. For in bodies here with us there is no real rest, either in wholes or in parts; but only in appearance. And this apparent rest is caused either by equilibrium, or by absolute predominancy of motions; by equilibrium, as in scales, which stand still if the weights be equal; by predominancy, as in watering-pots with holes in them, where the water rests and is kept from falling out by the predominancy of the Motion of Connexion. But it should be observed, as I have said, how far these yielding motions carry their resistance. For if a man be pinned to the ground, tied hand and foot, or otherwise held fast, and yet struggle to rise with all his might, the resistance is not the less, though it be unsuccessful. But the real state

of the case (I mean whether by predominancy the yielding motion is, so to speak, annihilated, or whether rather a resistance is continued, though we cannot see it) will perhaps, though latent in the conflicts of motions, be apparent in their concurrence. For example, let trial be made in shooting. See how far a gun will carry a ball straight, or as they say point blank; and then try whether, if it be fired upwards, the stroke will be feebler than when it is fired downwards, where the Motion of Gravity concurs with the blow.

Lastly, such Canons of Predominance as we meet with should be collected; for instance, that the more common the good sought, the stronger the motion. Thus the Motion of Connexion, which regards communion with the universe, is stronger than the Motion of Gravity, which regards only communion with dense bodies. Again, that appetites which aim at a private good seldom prevail against appetites which aim at a more public good, except in small quantities; rules which I wish held good in politics.

XLIX.

Among Prerogative Instances I will put in the twenty-fifth place *Intimating Instances;* those I mean, which intimate or point out what is useful to man. For mere Power and mere Knowledge exalt human nature, but do not bless it. We must therefore gather from the whole store of things such as make most for the uses of life. But a more proper place for speaking of these will be when I come to treat of Applications to Practice. Besides in the work itself of Interpretation in each particular subject, I always assign a place to the *Human Chart*, or *Chart of things to be wished*

for. For to form judicious wishes is as much a part of knowledge as to ask judicious questions.

L.

Among Prerogative Instances I will put in the twenty-sixth place *Polychrest Instances*, or *Instances of General Use*. They are those which relate to a variety of cases and occur frequently; and therefore save no small amount of labour and fresh demonstration. Of the instruments and contrivances themselves the proper place for speaking will be when I come to speak of Applications to Practice and Modes of Experimenting. Moreover those which have been already discovered and come into use will be described in the particular histories of the several arts. At present I will subjoin a few general remarks on them as examples merely of this General Use.

Besides the simple bringing together and putting asunder of them, man operates upon natural bodies chiefly in seven ways: viz. either by exclusion of whatever impedes and disturbs; or by compressions, extensions, agitations, and the like; or by heat and cold; or by continuance in a suitable place; or by the checking and regulation of motion; or by special sympathies; or by the seasonable and proper alternation, series, and succession of all these ways, or at any rate of some of them.

With regard to the first; the common air, which is everywhere about us and pressing in, and the rays of the heavenly bodies, cause much disturbance. Whatever therefore serves to exclude them, may justly be reckoned among things of General Use. To this head belong the material and thickness of the vessels in

which the bodies are placed on which we are going to operate; also the perfect stopping up of vessels by consolidation and *lutum sapientiæ*, as the chemists call it. Also the closing in of substances by liquids poured on the outside is a thing of very great use; as when they pour oil on wine or juices of herbs, which spreading over the surface like a lid preserves them excellently from the injury of the air. Nor are powders bad things; for though they contain air mixed up with them, they yet repel the force of the body of air round about; as we see in the preservation of grapes and other fruits in sand and flour. It is good too to spread bodies over with wax, honey, pitch, and like tenacious substances, for the more perfect enclosure of them, and to keep off the air and heavenly bodies. I have sometimes tried the effect of laying up a vessel or some other body in quicksilver, which of all substances that can be poured round another is far the densest. Caverns again and subterraneous pits are of great use in keeping off the heat of the sun and that open air which preys upon bodies; and such are used in the North of Germany as granaries. The sinking of bodies in water has likewise the same effect; as I remember to have heard of bottles of wine being let down into a deep well to cool; but through accident or neglect being left there for many years, and then taken out; and that the wine was not only free from sourness or flatness, but much finer tasted; owing, it would seem, to a more exquisite commixture of its parts. And if the case require that bodies be let down to the bottom of the water, as in a river or the sea, without either touching the water or being enclosed in stopped vessels, but surrounded by air alone; there is good use in the ves-

sel which has been sometimes employed for working under water on sunk ships, whereby divers are enabled to remain a long while below, and take breath from time to time. This machine was a hollow bell made of metal, which being let down parallel to the surface of the water, carried with it to the bottom all the air it contained. It stood on three feet (like a tripod) the height of which was somewhat less than that of a man, so that the diver, when his breath failed, could put his head into the hollow of the bell, take breath, and then go on with his work. I have heard also of a sort of machine or boat capable of carrying men under water for some distance. Be that as it may, under such a vessel as I have described bodies of any sort can easily be suspended; and it is on that account that I have mentioned this experiment.

There is also another advantage in the careful and complete closing of bodies; for not only does it keep the outer air from getting in (of which I have already spoken), but also it keeps the spirit of the body, on which the operation is going on inside, from getting out. For it is necessary for one who operates on natural bodies to be certain of his total quantities; that is, that nothing evaporates or flows away. For then, and then only, are profound alterations made in bodies, when, while nature prevents annihilation, art prevents also the loss or escape of any part. On this subject there has prevailed a false opinion, which, if true, would make us well nigh despair of preserving the perfect quantity without diminution; namely, that the spirits of bodies, and air when rarefied by a high degree of heat, cannot be contained in closed vessels, but escape through their more delicate pores. To this

opinion men have been led by the common experiment of an inverted cup placed on water with a candle in it or a piece of paper lighted; the consequence of which is that the water is drawn up; and also by the similar experiment of cupping-glasses, which when heated over flame draw up the flesh. For in each of these experiments they imagine that the rarefied air escapes, and that its quantity being thereby diminished, the water or flesh comes up into its place by the Motion of Connexion. But this is altogether a mistake. For the air is not diminished in quantity, but contracted in space; nor does the motion of the rising of the water commence till the flame is extinguished or the air cooled; and therefore physicians, to make their cupping-glasses draw better, lay on them cold sponges dipped in water. And therefore there is no reason why men should be much afraid of the easy escape of air or spirits. For though it be true that the most solid bodies have pores, still air or spirit do not easily submit to such extremely fine comminution; just as water refuses to run out at very small chinks.

With regard to the second of the seven modes of operating above mentioned, it is particularly to be observed, that compression and such violent means have indeed with respect to local motion and the like a most powerful effect; as in machines and projectiles; an effect which even causes the destruction of organic bodies, and of such virtues as consist altogether in motion. For all life, nay all flame and ignition, is destroyed by compression; just as every machine is spoilt or deranged by the same. It causes the destruction likewise of virtues which consist in the position and coarser dissimilarity of parts. This is the case with

colours; for the whole flower has not the same colour as when it is bruised, nor the whole piece of amber as the same piece pulverised. So also it is with tastes; for there is not the same taste in an unripe pear as there is in a squeezed and softened one; for it manifestly contracts sweetness by the process. But for the more remarkable transformations and alterations of bodies of uniform structure such violent means are of little avail; since bodies do not acquire thereby a new consistency that is constant and quiescent, but one that is transitory, and ever striving to recover and liberate itself. It would not be amiss however to make some careful experiments for the purpose of ascertaining whether the condensation or the rarefaction of a body of nearly uniform structure (as air, water, oil, and the like), being induced by violence, can be made to be constant and fixed, and to become a kind of nature. This should first be tried by simple continuance, and then by means of helps and consents. And the trial might easily have been made (if it had but occurred to me) when I was condensing water, as mentioned above, by hammer and press, till it burst forth from its enclosure. For I should have left the flattened sphere to itself for a few days, and after that drawn off the water; that so I might have seen whether it would immediately occupy the same dimensions, which it had before condensation. If it had not done so, either immediately or at any rate soon after, we might have pronounced the condensation a constant one; if it had, it would have appeared that a restoration had taken place, and that the compression was transitory. Something of a similar kind I might have tried also with the expansion of air in the glass eggs. For after pow-

erful suction I might have stopped them suddenly and tightly; I might have left the eggs so stopped for some days; and then tried whether on opening the hole the air would be drawn up with a hissing noise; or whether on plunging them into water, as much water would be drawn up as there would have been at first without the delay. For it is probable—at least it is worth trying—that this might have been, and may be, the case; since in bodies of structure not quite so uniform, the lapse of time does produce such effects. For a stick bent for some time by compression does not recoil; and this must not be imputed to any loss of quantity in the wood through the lapse of time; since the same will be the case with a plate of steel, if the time be increased, and steel does not evaporate. But if the experiment succeed not with mere continuance, the business must not be abandoned, but other aids must be employed. For it is no small gain if by the application of violence we can communicate to bodies fixed and permanent natures. For thus air can be turned into water by condensation, and many other effects of the kind can be produced; man being more the master of violent motions than of the rest.

The third of the seven modes above-mentioned relates to that which whether in Nature or in Art is the great instrument of operation, viz. heat and cold. And herein man's power is clearly lame on one side. For we have the heat of fire, which is infinitely more potent and intense than the heat of the sun as it reaches us, or the warmth of animals. But we have no cold save such as is to be got in winter time, or in caverns, or by application of snow and ice; which is about as much perhaps in comparison as the heat of the sun at noon in

the torrid zone, increased by the reflexions of mountains and walls; for such heat as well as such cold can be endured by animals for a short time. But they are nothing to be compared to the heat of a burning furnace, or with any cold corresponding to it in intensity. Thus all things with us tend to rarefaction, and desiccation, and consumption; nothing hardly to condensation and inteneration, except by mixtures and methods that may be called spurious. Instances of cold therefore should be collected with all diligence; and such it seems may be found by exposing bodies on steeples in sharp frosts; by laying them in subterranean caverns; by surrounding them with snow and ice in deep pits dug for the purpose; by letting them down into wells; by burying them in quicksilver and metals; by plunging them into waters which petrify wood; by burying them in the earth, as the Chinese are said to do in the making of porcelain, where masses made for the purpose are left, we are told, under ground for forty or fifty years, and transmitted to heirs, as a kind of artificial minerals; and by similar processes. And so too all natural condensations caused by cold should be investigated, in order that, their causes being known, they may be imitated by art. Such we see in the sweating of marble and stones; in the dews condensed on the inside of window panes, towards morning, after a night's frost; in the formation and gathering of vapours into water under the earth, from which springs often bubble up. Everything of this kind should be collected.

Besides things which are cold to the touch, there are found others having the power of cold, which also condense; but which seem to act on the bodies of animals

only, and hardly on others. Of this sort we have many instances in medicines and plasters; some of which condense the flesh and tangible parts, as astringent and inspissatory medicaments; while others condense the spirits, as is most observable in soporifics. There are two ways in which spirits are condensed by medicaments soporific, or provocative of sleep; one by quieting their motion, the other by putting them to flight. Thus violets, dried rose leaves, lettuce, and like benedict or benignant medicaments, by their kindly and gently cooling fumes invite the spirits to unite, and quiet their eager and restless motion. Rose water too, applied to the nose in a fainting fit, causes the resolved and too relaxed spirits to recover themselves, and as it were cherishes them. But opiates and kindred medicaments put the spirits utterly to flight, by their malignant and hostile nature. And therefore if they be applied to an external part, the spirits immediately flee away from that part, and do not readily flow into it again; if taken internally, their fumes, ascending to the head, disperse in all directions the spirits contained in the ventricles of the brain; and these spirits thus withdrawing themselves, and unable to escape into any other part, are by consequence brought together and condensed, and sometimes are utterly choked and extinguished; though on the other hand these same opiates taken in moderation do by a secondary accident (namely, the condensation which succeeds the coming together) comfort the spirits, and render them more robust, and check their useless and inflammatory motions; whereby they contribute no little to the cure of diseases, and prolongation of life.

Nor should we omit the means of preparing bodies

to receive cold. Among others I may mention that water slightly warm is more easily frozen than quite cold.

Besides, since nature supplies cold so sparingly, we must do as the apothecaries do, who when they cannot get a simple, take its succedaneum or *quid pro quo*, as they call it; such as aloes for balsam, cassia for cinnamon. In like manner we should look round carefully to see if there be anything that will do instead of cold; that is to say, any means by which condensations can be effected in bodies otherwise than by cold, the proper office of which is to effect them. Such condensations, as far as yet appears, would seem to be limited to four. The first of these is caused by simple compression, which can do but little for permanent density, since bodies recoil, but which perhaps may be of use as an auxiliary. The second is caused by the contraction of the coarser parts in a body, after the escape of the finer; such as takes place in indurations by fire, in the repeated quenchings of metals, and like processes. The third is caused by the coming together of those homogeneous parts in a body which are the most solid, and which previously had been dispersed, and mixed with the less solid; as in the restoration of sublimated mercury, which occupies a far greater space in powder than as simple mercury, and similarly in all purging of metals from their dross. The fourth is brought about through sympathy, by applying substances which from some occult power condense. These sympathies or consents at present manifest themselves but rarely; which is no wonder, since before we succeed in discovering Forms and Configurations, we cannot hope for much from an inquiry into sympathies. With regard to the bodies of

animals indeed, there is no doubt that there are many medicines, whether taken internally or externally, which condense as it were by consent, as I have stated a little above. But in the case of inanimate substances such operation is rare. There has indeed been spread abroad, as well in books as in common rumour, the story of a tree in one of the Tercera or Canary Isles (I do not well remember which) which is constantly dripping; so as to some extent to supply the inhabitants with water. And Paracelsus says that the herb called *Ros Solis* is at noon and under a burning sun filled with dew, while all the other herbs round it are dry. But both of these stories I look upon as fabulous. If they were true, such instances would be of most signal use, and most worthy of examination. Nor do I conceive that those honey-dews, like manna, which are found on the leaves of the oak in the month of May, are formed and condensed by any peculiar property in the leaf of the oak; but that while they fall equally on all leaves, they are retained on those of the oak, as being well united, and not spongy as most of the others are.

As regards heat, man indeed has abundant store and command thereof; but observation and investigation are wanting in some particulars, and those the most necessary, let the alchemists say what they will. For the effects of intense heat are sought for and brought into view; but those of a gentler heat, which fall in most with the ways of nature, are not explored, and therefore are unknown. And therefore we see that by the heats generally used the spirits of bodies are greatly exalted, as in strong waters and other chemical oils; that the tangible parts are hardened, and, the volatile

being discharged, sometimes fixed; that the homogeneous parts are separated, while the heterogeneous are in a coarse way incorporated and mixed up together; above all that the junctures of composite bodies, and their more subtle configurations are broken up and confounded. Whereas the operations of a gentler heat ought to have been tried and explored, whereby more subtle mixtures and regular configurations might be generated and educed, after the model of nature, and in imitation of the works of the sun; as I have shadowed forth in the Aphorism on Instances of Alliance. For the operations of nature are performed by far smaller portions at a time, and by arrangements far more exquisite and varied than the operations of fire, as we use it now. And it is then that we shall see a real increase in the power of man, when by artificial heats and other agencies the works of nature can be represented in form, perfected in virtue, varied in quantity, and, I may add, accelerated in time. For the rust of iron is slow in forming, but the turning into *Crocus Martis* is immediate; and it is the same with verdigris and ceruse; crystal is produced by a long process, while glass is blown at once; stones take a long time to grow, while bricks are quickly baked. Meanwhile (to come to our present business), heats of every kind, with their effects, should be diligently collected from all quarters and investigated, — the heat of heavenly bodies by their rays direct, reflected, refracted, and united in burning-glasses and mirrors; the heat of lightning, of flame, of coal fire; of fire from different materials; of fire close and open, straitened and in full flow, modified in fine by the different structures of furnaces; of fire excited by blowing; of fire

quiescent and not excited; of fire removed to a greater or less distance; of fire passing through various media; moist heats, as of a vessel floating in hot water, of dung, of external and internal animal warmth, of confined hay; dry heats, as of ashes, lime, warm sand; in short heats of all kinds with their degrees.

But above all, we must try to investigate and discover the effects and operations of heat when applied and withdrawn gradually, orderly, and periodically, at due distances and for due times. For such orderly inequality is in truth the daughter of the heavens, and mother of generation; nor is anything great to be expected from a heat either vehement or precipitate or that comes by fits and starts. In vegetables this is most manifest; and also in the wombs of animals there is a great inequality of heat, from the motion, sleep, food and passions of the female in gestation; lastly in the wombs of the earth itself, those I mean in which metals and fossils are formed, the same inequality has place and force. Which makes the unskilfulness of some alchemists of the reformed school all the more remarkable, — who have conceived that by the equable warmth of lamps and the like, burning uniformly, they can attain their end. And so much for the operations and effects of heat. To examine them thoroughly would be premature, till the Forms of things and the Configurations of bodies have been further investigated and brought to light. For it will then be time to seek, apply, and adapt our instruments, when we are clear as to the pattern.

The fourth mode of operating is by continuance, which is as it were the steward and almoner of nature. Continuance I call it, when a body is left to itself for a

considerable time, being meanwhile defended from all external force. For then only do the internal motions exhibit and perfect themselves, when the extraneous and adventitious are stopped. Now the works of time are far subtler than those of fire. For wine cannot be so clarified by fire, as it is by time; nor are the ashes produced by fire so fine as the dust into which substances are resolved and wasted by ages. So too the sudden incorporations and mixtures precipitated by fire are far inferior to those which are brought about by time. And the dissimilar and varied configurations which bodies by continuance put on, such as putrefactions, are destroyed by fire or any violent heat. Meanwhile it would not be out of place to observe that the motions of bodies when quite shut up have in them something of violence. For such imprisonment impedes the spontaneous motions of the body. And therefore continuance in an open vessel is best for separations; in a vessel quite closed for commixtures; in a vessel partly closed, but with the air entering, for putrefactions. But indeed instances showing the effects and operations of continuance should be carefully collected from all quarters.

The regulation of motion (which is the fifth mode of operating) is of no little service. I call it regulation of motion, when one body meeting another impedes, repels, admits or directs its spontaneous motion. It consists for the most part in the shape and position of vessels. Thus the upright cone in alembics helps the condensation of vapours; the inverted cone in receivers helps the draining off of the dregs of sugar. Sometimes a winding form is required, and one that narrows and widens in turn, and the like. For all

percolation depends on this, that the meeting body opens the way to one portion of the body met and shuts it to another. Nor is the business of percolation or other regulation of motion always performed from without; it may also be done by a body within a body; as when stones are dropped into water to collect its earthy parts; or when syrups are clarified with the whites of eggs, that the coarser parts may adhere thereto, after which they may be removed. It is also to this regulation of motion that Telesius has rashly and ignorantly enough attributed the shapes of animals, which he says are owing to the channels and folds in the womb. But he should have been able to show the like formation in the shells of eggs, in which there are no wrinkles or inequalities. It is true however that the regulation of motion gives the shapes in moulding and casting.

Operations by consents or aversions (which is the sixth mode) often lie deeply hid. For what are called occult and specific properties, or sympathies and antipathies, are in great part corruptions of philosophy. Nor can we have much hope of discovering the consents of things before the discovery of Forms and Simple Configurations. For Consent is nothing else than the adaptation of Forms and Configurations to each other.

The broader and more general consents of things are not however quite so obscure. I will therefore begin with them. Their first and chief diversity is this, that some bodies differ widely as to density and rarity, but agree in configurations; while others agree as to density and rarity, but differ in configurations. For it has not been ill observed by the chemists in their triad of first principles, that sulphur and mercury run through

the whole universe. (For what they add about salt is absurd, and introduced merely to take in bodies earthy, dry, and fixed.) But certainly in these two one of the most general consents in nature does seem to be observable. For there is consent between sulphur, oil and greasy exhalation, flame, and perhaps the body of a star. So is there between mercury, water and watery vapours, air, and perhaps the pure and intersidereal ether. Yet these two quaternions or great tribes of things (each within its own limits) differ immensely in quantity of matter and density, but agree very well in configuration; as appears in numerous cases. On the other hand metals agree well together in quantity and density, especially as compared with vegetables, &c., but differ very widely in configuration; while in like manner vegetables and animals vary almost infinitely in their configurations, but in quantity of matter or density their variation is confined to narrow limits.

The next most general consent is that between primary bodies and their supports; that is, their menstrua and foods. We must therefore inquire, under what climates, in what earth, and at what depth, the several metals are generated; and so of gems, whether produced on rocks or in mines; also in what soil the several trees and shrubs and herbs thrive best, and take, so to speak, most delight; moreover what manurings, whether by dung of any sort, or by chalk, sea-sand, ashes, &c., do the most good; and which of them are most suitable and effective according to the varieties of soil. Again the grafting and inoculating of trees and plants, and the principle of it, that is to say, what plants prosper best on what stocks, depends much on sympathy. Under this head it would be an agreeable ex-

periment, which I have heard has been lately tried, of engrafting forest-trees (a practice hitherto confined to fruit-trees); whereby the leaves and fruit are greatly enlarged, and the trees made more shady. In like manner the different foods of animals should be noted under general heads, and with their negatives. For carnivorous animals cannot live on herbs; whence the order of Feuillans (though the will in man has more power over the body than in other animals) has after trial (they say) well nigh disappeared; the thing not being endurable by human nature. Also the different materials of putrefaction, whence animalculæ are generated, should be observed.

The consents of primary bodies with their subordinates (for such those may be considered which I have noted) are sufficiently obvious. To these may be added the consents of the senses with their objects. For these consents, since they are most manifest, and have been well observed and keenly sifted, may possibly shed great light on other consents also which are latent.

But the inner consents and aversions, or friendships and enmities, of bodies (for I am almost weary of the words sympathy and antipathy on account of the superstitions and vanities associated with them) are either falsely ascribed, or mixed with fables, or from want of observation very rarely met with. For if it be said that there is enmity between the vine and colewort, because when planted near each other they do not thrive; the reason is obvious — that both of these plants are succulent and exhaust the ground, and thus one robs the other. If it be said that there is consent and friendship between corn and the corn-cockle or the wild poppy, because these herbs hardly come up except

in ploughed fields; it should rather be said that there is enmity between them, because the poppy and corn-cockle are emitted and generated from a juice of the earth which the corn has left and rejected; so that sowing the ground with corn prepares it for their growth. And of such false ascriptions there is a great number. As for fables, they should be utterly exterminated. There remains indeed a scanty store of consents which have been approved by sure experiment; such as those of the magnet and iron, of gold and quicksilver, and the like. And in chemical experiments on metals there are found also some others worthy of observation. But they are found in greatest abundance (if one may speak of abundance in such a scarcity) in certain medicines, which by their occult (as they are called) and specific properties have relation either to limbs, or humours, or diseases, or sometimes to individual natures. Nor should we omit the consents between the motions and changes of the moon and the affections of bodies below; such as may be gathered and admitted, after strict and honest scrutiny, from experiments in agriculture, navigation, medicine, and other sciences. But the rarer all the instances of more secret consents are, the greater the diligence with which they should be sought after, by means of faithful and honest traditions and narrations; provided this be done without any levity or credulity, but with an anxious and (so to speak) a doubting faith. There remains a consent of bodies, inartificial perhaps in mode of operation, but in use a Polychrest, which should in no wise be omitted, but examined into with careful attention. I mean the proneness or reluctance of bodies to draw together or unite by composition or simple ap-

position. For some bodies are mixed together and incorporated easily, but others with difficulty and reluctance. Thus powders mix best with water; ashes and lime with oils, and so on. Nor should we merely collect instances of the propensity or aversion of bodies for mixture, but also of the collocation of their parts, of their distribution and digestion when they are mixed, and finally of their predominancy after the mixture is completed.

There remains the seventh and last of the seven modes of operation, namely, the means of operating by the alternation of the former six; but it would not be seasonable to bring forward examples of this, till our search has been carried somewhat more deeply into the others singly. Now a series or chain of such alternations, adapted to particular effects, is a thing at once most difficult to discover, and most effective to work with. But men are utterly impatient both of the inquiry and the practice; though it is the very thread of the labyrinth, as regards works of any magnitude. Let this suffice to exemplify the Polychrest Instances.

LI.

Among Prerogative Instances I will put in the twenty-seventh and last place *Instances of Magic;* by which I mean those wherein the material or efficient cause is scanty or small, as compared with the work and effect produced; so that, even where they are common, they seem like miracles; some at first sight, others even after attentive consideration. These indeed nature of herself supplies sparingly; but what she may do when her folds have been shaken out, and after the discovery of Forms and Processes and Con-

figurations, time will show. But these magical effects (according to my present conjecture) are brought about in three ways; either by self-multiplication, as in fire, and in poisons called specific, and also in motions which are increased in power by passing from wheel to wheel; or by excitation or invitation in another body, as in the magnet, which excites numberless needles without losing any of its virtue, or in yeast and the like; or by anticipation of motion, as in the case already mentioned of gunpowder and cannons and mines. Of which ways the two former require a knowledge of consents; the third, a knowledge of the measurement of motions. Whether there be any mode of changing bodies *per minima* (as they call it) and of transposing the subtler configurations of matter (a thing required in every sort of transformation of bodies) so that art may be enabled to do in a short time that which nature accomplishes by many windings, is a point on which I have at present no sure indications. And as in matters solid and true I aspire to the ultimate and supreme, so do I for ever hate all things vain and tumid, and do my best to discard them.

LII.

So much then for the Dignities or Prerogatives of Instances. It must be remembered however that in this Organum of mine I am handling logic, not philosophy. But since my logic aims to teach and instruct the understanding, not that it may with the slender tendrils of the mind snatch at and lay hold of abstract notions (as the common logic does), but that it may in very truth dissect nature, and discover the virtues and actions of bodies, with their laws as determined in matter; so that this science flows not merely from the

nature of the mind, but also from the nature of things; no wonder that it is everywhere sprinkled and illustrated with speculations and experiments in nature, as examples of the art I teach. It appears then from what has been said that there are twenty-seven Prerogative Instances; namely, Solitary Instances; Migratory Instances; Striking Instances; Clandestine Instances; Constitutive Instances; Conformable Instances; Singular Instances; Deviating Instances; Bordering Instances; Instances of Power; Instances of Companionship and of Enmity; Subjunctive Instances; Instances of Alliance; Instances of the Fingerpost; Instances of Divorce; Instances of the Door; Summoning Instances; Instances of the Road; Instances Supplementary; Dissecting Instances; Instances of the Rod; Instances of the Course; Doses of Nature; Instances of Strife; Intimating Instances; Polychrest Instances; Magical Instances. Now the use of these instances, wherein they excel common instances, is found either in the Informative part or in the Operative, or in both. As regards the Informative, they assist either the senses or the understanding: the senses, as the five Instances of the Lamp: the understanding, either by hastening the Exclusion of the Form, as Solitary Instances;—or by narrowing and indicating more nearly the Affirmative of the Form, as Instances Migratory, Striking, of Companionship, and Subjunctive;—or by exalting the understanding and leading it to genera and common natures; either immediately, as Instances Clandestine, Singular, and of Alliance; or in the next degree, as Constitutive; or in the lowest, as Conformable;—or by setting the understanding right when led astray by habit, as Devi-

ating Instances;—or by leading it to the Great Form or Fabric of the Universe, as Bordering Instances;—or by guarding it against false forms and causes, as Instances of the Fingerpost and of Divorce. In the Operative Part, they either point out, or measure, or facilitate practice. They point it out, by showing with what we should begin, that we may not go again over old ground, as Instances of Power; or to what we should aspire if means be given, as Intimating Instances. The four Mathematical Instances measure practice: Polychrest and Magical Instances facilitate it.

Again out of these twenty-seven instances there are some of which we must make a collection at once, as I said above, without waiting for the particular investigation of natures. Of this sort are Instances Conformable, Singular, Deviating, Bordering, of Power, of the Dose, Intimating, Polychrest, and Magical. For these either help and set right the understanding and senses, or furnish practice with her tools in a general way. The rest need not be inquired into till we come to make Tables of Presentation for the work of the Interpreter concerning some particular nature. For the instances marked and endowed with these Prerogatives are as a soul amid the common instances of Presentation, and as I said at first, a few of them do instead of many; and therefore in the formation of the Tables they must be investigated with all zeal, and set down therein. It was necessary to handle them beforehand because I shall have to speak of them in what follows. But now I must proceed to the supports and rectifications of Induction, and then to concretes, and Latent Processes, and Latent Configurations, and the rest, as set forth in order in the twenty-

first Aphorism; that at length (like an honest and faithful guardian) I may hand over to men their fortunes, now their understanding is emancipated and come as it were of age; whence there cannot but follow an improvement in man's estate, and an enlargement of his power over nature. For man by the fall fell at the same time from his state of innocency and from his dominion over creation. Both of these losses however can even in this life be in some part repaired; the former by religion and faith, the latter by arts and sciences. For creation was not by the curse made altogether and for ever a rebel, but in virtue of that charter "In the sweat of thy face shalt thou eat bread," it is now by various labours (not certainly by disputations or idle magical ceremonies, but by various labours) at length and in some measure subdued to the supplying of man with bread; that is, to the uses of human life.

END OF THE SECOND BOOK OF THE NEW ORGANUM.

PREPARATIVE

TOWARDS A

NATURAL AND EXPERIMENTAL HISTORY.

DESCRIPTION

OF A

NATURAL AND EXPERIMENTAL HISTORY,

SUCH AS MAY SERVE FOR THE FOUNDATION OF A TRUE PHILOSOPHY.

My object in publishing my Instauration by parts is that some portion of it may be put out of peril. A similar reason induces me to subjoin here another small portion of the work, and to publish it along with that which has just been set forth. This is the description and delineation of a Natural and Experimental History such as may serve to build philosophy upon, and containing material true and copious and aptly digested for the work of the Interpreter which follows. The proper place for it would be when I come in due course to the *Preparatives* of Inquiry. I have thought it better however to introduce it at once without waiting for that. For a history of this kind, such as I conceive and shall presently describe, is a thing of very great size, and cannot be executed without great labour and expense; requiring as it does many people to help, and being (as I have said elsewhere) a kind of royal work. It occurs to me therefore that it may not be amiss to try if there be any others who will take these matters in hand; so that

while I go on with the completion of my original design, this part which is so manifold and laborious may even during my life (if it so please the Divine Majesty) be prepared and set forth, others applying themselves diligently to it along with me; the rather because my own strength (if I should have no one to help me) is hardly equal to such a province. For as much as relates to the work itself of the intellect, I shall perhaps be able to master that by myself; but the materials on which the intellect has to work are so widely spread, that one must employ factors and merchants to go everywhere in search of them and bring them in. Besides I hold it to be somewhat beneath the dignity of an undertaking like mine that I should spend my own time in a matter which is open to almost every man's industry. That however which is the main part of the matter I will myself now supply, by diligently and exactly setting forth the method and description of a history of this kind, such as shall satisfy my intention; lest men for want of warning set to work the wrong way, and guide themselves by the example of the natural histories now in use, and so go far astray from my design. Meanwhile what I have often said I must here emphatically repeat; that if all the wits of all the ages had met or shall hereafter meet together; if the whole human race had applied or shall hereafter apply themselves to philosophy, and the whole earth had been or shall be nothing but academies and colleges and schools of learned men; still without a natural and experimental history such as I am going to prescribe, no progress worthy of the human race could have been made or can be made in philosophy and the sciences. Whereas on the other hand, let

such a history be once provided and well set forth, and let there be added to it such auxiliary and light-giving experiments as in the very course of interpretation will present themselves or will have to be found out; and the investigation of nature and of all sciences will be the work of a few years. This therefore must be done, or the business must be given up. For in this way, and in this way only, can the foundations of a true and active philosophy be established; and then will men wake as from deep sleep, and at once perceive what a difference there is between the dogmas and figments of the wit and a true and active philosophy, and what it is in questions of nature to consult nature herself.

First then I will give general precepts for the composition of this history; then I will set out the particular figure of it, inserting sometimes as well the purpose to which the inquiry is to be adapted and referred as the particular point to be inquired; in order that a good understanding and forecast of the mark aimed at may suggest to men's minds other things also which I may perhaps have overlooked. This history I call *Primary History*, or the *Mother History*.

APHORISMS

ON THE

COMPOSITION OF THE PRIMARY HISTORY.

Aphorism

I.

Nature exists in three states, and is subject as it were to three kinds of regimen. Either she is free, and develops herself in her own ordinary course; or she is forced out of her proper state by the perverseness and insubordination of matter and the violence of impediments; or she is constrained and moulded by art and human ministry. The first state refers to the *species* of things; the second to *monsters;* the third to *things artificial.* For in things artificial nature takes orders from man, and works under his authority: without man, such things would never have been made. But by the help and ministry of man a new face of bodies, another universe or theatre of things, comes into view. Natural History therefore is threefold. It treats of the *liberty* of nature, or the *errors* of nature, or the *bonds* of nature: so that we may fairly distribute it into history of *Generations*, of *Pretergenerations*, and of *Arts;* which last I also call *Mechanical* or *Experimental* history. And yet I do not make it a rule

that these three should be kept apart and separately treated. For why should not the history of the monsters in the several species be joined with the history of the species themselves? And things artificial again may sometimes be rightly joined with the species, though sometimes they will be better kept separate. It will be best therefore to consider these things as the case arises. For too much method produces iterations and prolixity as well as none at all.

II.

Natural History, which in its subject (as I said) is threefold, is in its use twofold. For it is used either for the sake of the knowledge of the particular things which it contains, or as the primary material of philosophy and the stuff and subject-matter of true induction. And it is this latter which is now in hand; now, I say, for the first time: nor has it ever been taken in hand till now. For neither Aristotle, nor Theophrastus, nor Dioscorides, nor Caius Plinius, ever set this before them as the end of natural history. And the chief part of the matter rests in this: that they who shall hereafter take it upon them to write natural history should bear this continually in mind — that they ought not to consult the pleasure of the reader, no nor even that utility which may be derived immediately from their narrations; but to seek out and gather together such store and variety of things as may suffice for the formation of true axioms. Let them but remember this, and they will find out for themselves the method in which the history should be composed. For the end rules the method.

III.

But the more difficult and laborious the work is, the more ought it to be discharged of matters superfluous. And therefore there are three things upon which men should be warned to be sparing of their labour, — as those which will immensely increase the mass of the work, and add little or nothing to its worth.

First then, away with antiquities, and citations or testimonies of authors; also with disputes and controversies and differing opinions; everything in short which is philological. Never cite an author except in a matter of doubtful credit: never introduce a controversy unless in a matter of great moment. And for all that concerns ornaments of speech, similitudes, treasury of eloquence, and such like emptinesses, let it be utterly dismissed. Also let all those things which are admitted be themselves set down briefly and concisely, so that they may be nothing less than words. For no man who is collecting and storing up materials for ship-building or the like, thinks of arranging them elegantly, as in a shop, and displaying them so as to please the eye; all his care is that they be sound and good, and that they be so arranged as to take up as little room as possible in the warehouse. And this is exactly what should be done here.

Secondly, that superfluity of natural histories in descriptions and pictures of species, and the curious variety of the same, is not much to the purpose. For small varieties of this kind are only a kind of sports and wanton freaks of nature; and come near to the nature of individuals. They afford a pleasant recreation in wandering among them and looking at them

as objects in themselves; but the information they yield to the sciences is slight and almost superfluous.

Thirdly, all superstitious stories (I do not say stories of prodigies, when the report appears to be faithful and probable; but superstitious stories) and experiments of ceremonial magic should be altogether rejected. For I would not have the infancy of philosophy, to which natural history is as a nursing-mother, accustomed to old wives' fables. The time will perhaps come (after we have gone somewhat deeper into the investigation of nature) for a light review of things of this kind; that if there remain any grains of natural virtue in these dregs, they may be extracted and laid up for use. In the meantime they should be set aside. Even the experiments of natural magic should be sifted diligently and severely before they are received; especially those which are commonly derived from vulgar sympathies and antipathies, with great sloth and facility both of believing and inventing.

And it is no small thing to relieve natural history from the three superfluities above mentioned, which would otherwise fill volumes. Nor is this all. For in a great work it is no less necessary that what is admitted should be written succinctly than that what is superfluous should be rejected; though no doubt this kind of chastity and brevity will give less pleasure both to the reader and the writer. But it is always to be remembered that this which we are now about is only a granary and storehouse of matters, not meant to be pleasant to stay or live in, but only to be entered as occasion requires, when anything is wanted for the work of the *Interpreter*, which follows.

IV.

In the history which I require and design, special care is to be taken that it be of wide range and made to the measure of the universe. For the world is not to be narrowed till it will go into the understanding (which has been done hitherto), but the understanding to be expanded and opened till it can take in the image of the world, as it is in fact. For that fashion of taking few things into account, and pronouncing with reference to a few things, has been the ruin of everything. To resume then the divisions of natural history which I made just now,—viz. that it is a history of Generations, Pretergenerations, and Arts,—I divide the History of Generations into five parts. The first, of Ether and things Celestial. The second, of Meteors and the regions (as they call them) of Air; viz. of the tracts which lie between the moon and the surface of the earth; to which part also (for order's sake, however the truth of the thing may be) I assign Comets of whatever kind, both higher and lower. The third, of Earth and Sea. The fourth, of the Elements (as they call them), flame or fire, air, water, earth: understanding however by Elements, not the first principles of things, but the greater masses of natural bodies. For the nature of things is so distributed that the quantity or mass of some bodies in the universe is very great, because their configurations require a texture of matter easy and obvious; such as are those four bodies which I have mentioned; while of certain other bodies the quantity is small and weakly supplied, because the texture of matter which they require is very complex and subtle, and for the most part deter-

minate and organic; such as are the species of natural things,—metals, plants, animals. Hence I call the former kind of bodies the *Greater Colleges*, the latter the *Lesser Colleges*. Now the fourth part of the history is of those Greater Colleges—under the name of Elements, as I said. And let it not be thought that I confound this fourth part with the second and third, because in each of them I have mentioned air, water, and earth. For the history of these enters into the second and third, as they are integral parts of the world, and as they relate to the fabric and configuration of the universe. But in the fourth is contained the history of their own substance and nature, as it exists in their several parts of uniform structure, and without reference to the whole. Lastly, the fifth part of the history contains the Lesser Colleges, or Species; upon which natural history has hitherto been principally employed.

As for the history of Pretergenerations, I have already said that it may be most conveniently joined with the history of Generations; I mean the history of prodigies which are natural. For the superstitious history of marvels (of whatever kind) I remit to a quite separate treatise of its own; which treatise I do not wish to be undertaken now at first, but a little after, when the investigation of nature has been carried deeper.

History of Arts, and of Nature as changed and altered by Man, or Experimental History, I divide into three. For it is drawn either from mechanical arts, or from the operative part of the liberal arts; or from a number of crafts and experiments which have not yet grown into an art properly so called, and which some-

times indeed turn up in the course of most ordinary experience, and do not stand at all in need of art.

As soon therefore as a history has been completed of all these things which I have mentioned, namely, Generations, Pretergenerations, Arts and Experiments, it seems that nothing will remain unprovided whereby the sense can be equipped for the information of the understanding. And then shall we be no longer kept dancing within little rings, like persons bewitched, but our range and circuit will be as wide as the compass of the world.

V.

Among the parts of history which I have mentioned, the history of Arts is of most use, because it exhibits things in motion, and leads more directly to practice. Moreover it takes off the mask and veil from natural objects, which are commonly concealed and obscured under the variety of shapes and external appearance. Finally, the vexations of art are certainly as the bonds and handcuffs of Proteus, which betray the ultimate struggles and efforts of matter. For bodies will not be destroyed or annihilated; rather than that they will turn themselves into various forms. Upon this history therefore, mechanical and illiberal as it may seem, (all fineness and daintiness set aside) the greatest diligence must be bestowed.

Again, among the particular arts those are to be preferred which exhibit, alter, and prepare natural bodies and materials of things; such as agriculture, cookery, chemistry, dyeing; the manufacture of glass, enamel, sugar, gunpowder, artificial fires, paper, and the like. Those which consist principally in the subtle

motion of the hands or instruments are of less use; such as weaving, carpentry, architecture, manufacture of mills, clocks, and the like; although these too are by no means to be neglected, both because many things occur in them which relate to the alterations of natural bodies, and because they give accurate information concerning local motion, which is a thing of great importance in very many respects.

But in the whole collection of this history of Arts, it is especially to be observed and constantly borne in mind, that not only those experiments in each art which serve the purpose of the art itself are to be received, but likewise those which turn up anyhow by the way. For example, that locusts or crabs, which were before of the colour of mud, turn red when baked, is nothing to the table; but this very instance is not a bad one for investigating the nature of redness, seeing that the same thing happens in baked bricks. In like manner the fact that meat is sooner salted in winter than in summer, is not only important for the cook that he may know how to regulate the pickling, but is likewise a good instance for showing the nature and impression of cold. Therefore it would be an utter mistake to suppose that my intention would be satisfied by a collection of experiments of arts made only with the view of thereby bringing the several arts to greater perfection. For though this be an object which in many cases I do not despise, yet my meaning plainly is that all mechanical experiments should be as streams flowing from all sides into the sea of philosophy. But how to select the more important instances in every kind (which are principally and with the greatest diligence to be sought and as it were

hunted out) is a point to be learned from the prerogatives of instances.

VI.

In this place also is to be resumed that which in the 99th 119th, and 120th Aphorisms of the first book I treated more at large, but which it may be enough here to enjoin shortly by way of precept; namely, that there are to be received into this history, first, things the most ordinary, such as it might be thought superfluous to record in writing, because they are so familiarly known; secondly, things mean, illiberal, filthy (for "to the pure all things are pure," and if money obtained from Vespasian's tax smelt well, much more does light and information from whatever source derived); thirdly, things trifling and childish (and no wonder, for we are to become again as little children); and lastly, things which seem over subtle, because they are in themselves of no use. For the things which will be set forth in this history are not collected (as I have already said) on their own account; and therefore neither is their importance to be measured by what they are worth in themselves, but according to their indirect bearing upon other things, and the influence they may have upon philosophy.

VII.

Another precept is, that everything relating both to bodies and virtues in nature be set forth (as far as may be) numbered, weighed, measured, defined. For it is works we are in pursuit of, not speculations; and practical working comes of the due combination of physics and mathematics. And therefore the exact revolutions

and distances of the planets — in the history of the heavenly bodies; the compass of the land and the superficial space it occupies in comparison of the waters — in the history of earth and sea; how much compression air will bear without strong resistance — in the history of air; how much one metal outweighs another — in the history of metals; and numberless other particulars of that kind are to be ascertained and set down. And when exact proportions cannot be obtained, then we must have recourse to indefinite estimates and comparatives. As for instance (if we happen to distrust the calculations of astronomers as to the distances of the planets), that the moon is within the shadow of the earth; that Mercury is beyond the moon; and the like. Also when mean proportions cannot be had, let extremes be proposed; as that a weak magnet will raise so many times its own weight of iron, while the most powerful will raise sixty times its own weight (as I have myself seen in the case of a very small armed magnet). I know well enough that these definite instances do not occur readily or often, but that they must be sought for as auxiliaries in the course of interpretation itself when they are most wanted. But nevertheless if they present themselves accidentally, provided they do not too much interrupt the progress of the natural history, they should also be entered therein.

VIII.

With regard to the credit of the things which are to be admitted into the history; they must needs be either certainly true, doubtful whether true or not, or certainly not true. Things of the first kind should be set down simply; things of the second kind with a qualify-

ing note, such as "it is reported," "they relate," "I have heard from a person of credit," and the like. For to add the arguments on either side would be too laborious and would certainly interrupt the writer too much. Nor is it of much consequence to the business in hand; because (as I have said in the 118th Aphorism of the first book) mistakes in experimenting, unless they abound everywhere, will be presently detected and corrected by the truth of axioms. And yet if the instance be of importance, either from its own use or because many other things may depend upon it, then certainly the name of the author should be given; and not the name merely, but it should be mentioned withal whether he took it from report, oral or written (as most of Pliny's statements are), or rather affirmed it of his own knowledge; also whether it was a thing which happened in his own time or earlier; and again whether it was a thing of which, if it really happened, there must needs have been many witnesses; and finally whether the author was a vain-speaking and light person, or sober and severe; and the like points, which bear upon the weight of the evidence. Lastly things which though certainly not true are yet current and much in men's mouths, having either through neglect or from the use of them in similitudes prevailed now for many ages, (as that the diamond binds the magnet, garlic weakens it; that amber attracts everything except basil; and other things of that kind) these it will not be enough to reject silently; they must be in express words proscribed, that the sciences may be no more troubled with them.

Besides, it will not be amiss, when the source of any vanity or credulity happens to present itself, to make a

note of it; as for example, that the power of exciting Venus is ascribed to the herb *Satyrion*, because its root takes the shape of testicles; when the real cause of this is that a fresh bulbous root grows upon it every year, last year's root still remaining; whence those twin bulbs. And it is manifest that this is so; because the new root is always found to be solid and succulent, the old withered and spongy. And therefore it is no marvel if one sinks in water and the other swims; which nevertheless goes for a wonder, and has added credit to the other virtues ascribed to this herb.

IX.

There are also some things which may be usefully added to the natural history, and which will make it fitter and more convenient for the work of the interpreter, which follows. They are five.

First, questions (I do not mean as to causes but as to the fact) should be added, in order to provoke and stimulate further inquiry; as in the history of Earth and Sea, whether the Caspian ebbs and flows, and at how many hours' interval; whether there is any Southern Continent, or only islands; and the like.

Secondly, in any new and more subtle experiment the manner in which the experiment was conducted should be added, that men may be free to judge for themselves whether the information obtained from that experiment be trustworthy or fallacious; and also that men's industry may be roused to discover if possible methods more exact.

Thirdly, if in any statement there be anything doubtful or questionable, I would by no means have it suppressed or passed in silence, but plainly and perspicu-

ously set down by way of note or admonition. For I want this primary history to be compiled with a most religious care, as if every particular were stated upon oath; seeing that it is the book of God's works, and (so far as the majesty of heavenly may be compared with the humbleness of earthly things) a kind of second Scripture.

Fourthly, it would not be amiss to intersperse observations occasionally, as Pliny has done; as in the history of Earth and Sea, that the figure of the earth (as far as it is yet known) compared with the seas, is narrow and pointed towards the south, wide and broad towards the north; the figure of the sea contrary: — that the great oceans intersect the earth in channels running north and south, not east and west; except perhaps in the extreme polar regions. It is also very good to add canons (which are nothing more than certain general and catholic observations); as in the history of the Heavenly Bodies, that Venus is never distant more than 46 parts from the sun; Mercury never more than 23; and that the planets which are placed above the sun move slowest when they are furthest from the earth, those under the sun fastest. Moreover there is another kind of observation to be employed, which has not yet come into use, though it be of no small importance. This is, that to the enumeration of things which are should be subjoined an enumeration of things which are not. As in the history of the Heavenly Bodies, that there is not found any star oblong or triangular, but that every star is globular; either globular simply, as the moon; or apparently angular, but globular in the middle, as the other stars; or apparently radiant but globular in the middle, as the sun; — or that the

stars are scattered about the sky in no order at all; so that there is not found among them either quincunx or square, or any other regular figure (howsoever the names be given of Delta, Crown, Cross, Chariot, &c.), — scarcely so much as a straight line; except perhaps in the belt and dagger of Orion.

Fifthly, that may perhaps be of some assistance to an inquirer which is the ruin and destruction of a believer; viz. a brief review, as in passage, of the opinions now received, with their varieties and sects; that they may touch and rouse the intellect, and no more.

X.

And this will be enough in the way of general precepts; which if they be diligently observed, the work of the history will at once go straight towards its object and be prevented from increasing beyond bounds. But if even as here circumscribed and limited it should appear to some poor-spirited person a vast work — let him turn to the libraries; and there among other things let him look at the bodies of civil and canonical law on one side, and at the commentaries of doctors and lawyers on the other; and see what a difference there is between the two in point of mass and volume. For we (who as faithful secretaries do but enter and set down the laws themselves of nature and nothing else) are content with brevity, and almost compelled to it by the condition of things; whereas opinions, doctrines, and speculations are without number and without end.

And whereas in the Plan of the Work I have spoken of the *Cardinal Virtues* in nature, and said that a history of these must also be collected and written before we come to the work of Interpretation; I have not for-

gotten this, but I reserve this part for myself; since until men have begun to be somewhat more closely intimate with nature, I cannot venture to rely very much on other people's industry in that matter.

And now should come the delineation of the particular histories. But I have at present so many other things to do that I can only find time to subjoin a Catalogue of their titles. As soon however as I have leisure for it, I mean to draw up a set of questions on the several subjects, and to explain what points with regard to each of the histories are especially to be inquired and collected, as conducing to the end I have in view, — like a kind of particular Topics. In other words, I mean (according to the practice in civil causes) in this great Plea or Suit granted by the divine favour and providence (whereby the human race seeks to recover its right over nature), to examine nature herself and the arts upon interrogatories.

CATALOGUE

OF

PARTICULAR HISTORIES

BY TITLES.

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1. History of the Heavenly Bodies; or Astronomical History.
2. History of the Configuration of the Heaven and the parts thereof towards the Earth and the parts thereof; or Cosmographical History.
3. History of Comets.
4. History of Fiery Meteors.
5. History of Lightnings, Thunderbolts, Thunders, and Coruscations.
6. History of Winds and Sudden Blasts and Undulations of the Air.
7. History of Rainbows.
8. History of Clouds, as they are seen above.
9. History of the Blue Expanse, of Twilight, of Mock-Suns, Mock-Moons, Haloes, various colours of the Sun; and of every variety in the aspect of the heavens caused by the medium.
10. History of Showers, Ordinary, Stormy, and Prodigious; also of Waterspouts (as they are called); and the like.

11. History of Hail, Snow, Frost, Hoar-frost, Fog, Dew, and the like.
12. History of all other things that fall or descend from above, and that are generated in the upper region.
13. History of Sounds in the upper region (if there be any), besides Thunder.
14. History of Air as a whole, or in the Configuration of the World.
15. History of the Seasons or Temperatures of the Year, as well according to the variations of Regions as according to accidents of Times and periods of Years; of Floods, Heats, Droughts, and the like.
16. History of Earth and Sea; of the Shape and Compass of them, and their Configurations compared with each other; and of their broadening or narrowing; of Islands in the Sea; of Gulfs of the Sea, and Salt Lakes within the Land; Isthmuses and Promontories.
17. History of the Motions (if any be) of the Globe of Earth and Sea; and of the Experiments from which such motions may be collected.
18. History of the greater Motions and Perturbations in Earth and Sea; Earthquakes, Tremblings and Yawnings of the Earth, Islands newly appearing: Floating Islands; Breakings off of Land by entrance of the Sea, Encroachments and Inundations and contrariwise Recessions of the Sea; Eruptions of Fire from the Earth; Sudden Eruptions of Waters from the Earth; and the like.
19. Natural History of Geography; of Mountains, Vallies, Woods, Plains, Sands, Marshes, Lakes, Riv-

ers, Torrents, Springs, and every variety of their course, and the like; leaving apart Nations, Provinces, Cities, and such like matters pertaining to Civil life.

20. History of Ebbs and Flows of the Sea; Currents, Undulations, and other Motions of the Sea.
21. History of the other Accidents of the Sea; its Saltness, its various Colours, its Depth; also of Rocks, Mountains and Vallies under the Sea, and the like.

Next come Histories of the Greater Masses.

22. History of Flame and of things Ignited.
23. History of Air, in Substance, not in the Configuration of the World.
24. History of Water, in Substance, not in the Configuration of the World.
25. History of Earth and the diversity thereof, in Substance, not in the Configuration of the World.

Next come Histories of Species.

26. History of perfect Metals, Gold, Silver; and of the Mines, Veins, Marcasites of the same; also of the Working in the Mines.
27. History of Quicksilver.
28. History of Fossils; as Vitriol, Sulphur, &c.
29. History of Gems; as the Diamond, the Ruby, &c.
30. History of Stones; as Marble, Touchstone, Flint, &c.
31. History of the Magnet.
32. History of Miscellaneous Bodies, which are neither entirely Fossil nor Vegetable; as Salts, Amber, Ambergris, &c.
33. Chemical History of Metals and Minerals.

34. History of Planets, Trees, Shrubs, Herbs; and of their parts, Roots, Stalks, Wood, Leaves, Flowers, Fruits, Seeds, Gums, &c.
35. Chemical History of Vegetables.
36. History of Fishes, and the Parts and Generation of them.
37. History of Birds, and the Parts and Generation of them.
38. History of Quadrupeds, and the Parts and Generation of them.
39. History of Serpents, Worms, Flies, and other insects; and of the Parts and Generation of them.
40. Chemical History of the things which are taken by Animals.

Next come Histories of Man.

41. History of the Figure and External Limbs of Man, his Stature, Frame, Countenance and Features; and of the variety of the same according to Races and Climates, or other smaller differences.
42. Physiognomical History of the same.
43. Anatomical History, or of the Internal Members of Man; and of the variety of them, as it is found in the Natural Frame and Structure, and not merely as regards Diseases and Accidents out of the course of Nature.
44. History of the parts of Uniform Structure in Man; as Flesh, Bones, Membranes, &c.
45. History of Humours in Man; Blood, Bile, Seed, &c.
46. History of Excrements; Spittle, Urine, Sweats, Stools, Hair of the Head, Hairs of the Body, Whitlows, Nails, and the like.

47. History of Faculties; Attraction, Digestion, Retention, Expulsion, Sanguification, Assimilation of Aliment into the members, conversion of Blood and Flower of Blood into Spirit, &c.
48. History of Natural and Involuntary Motions; as Motion of the Heart, the Pulses, Sneezing, Lungs, Erection, &c.
49. History of Motions partly Natural and partly Violent; as of Respiration, Cough, Urine, Stool, &c.
50. History of Voluntary Motions; as of the Instruments of Articulation of Words; Motions of the Eyes, Tongue, Jaws, Hands, Fingers; of Swallowing, &c.
51. History of Sleep and Dreams.
52. History of different habits of Body — Fat, Lean; of the Complexions (as they call them), &c.
53. History of the Generation of Man.
54. History of Conception, Vivification, Gestation in the Womb, Birth, &c.
55. History of the Food of Man; and of all things Eatable and Drinkable; and of all Diet; and of the variety of the same according to nations and smaller differences.
56. History of the Growth and Increase of the Body, in the whole and in its parts.
57. History of the Course of Age; Infancy, Boyhood, Youth, Old Age; of Length and Shortness of Life, and the like, according to nations and lesser differences.
58. History of Life and Death.

59. History Medicinal of Diseases, and the Symptoms and Signs of them.

60. History Medicinal of the Treatment and Remedies and Cures of Diseases.
61. History Medicinal of those things which preserve the Body and the Health.
62. History Medicinal of those things which relate to the Form and Comeliness of the Body.
63. History Medicinal of those things which alter the Body, and pertain to Alterative Regimen.
64. History of Drugs.
65. History of Surgery.
66. Chemical History of Medicines.
67. History of Vision, and of things Visible.
68. History of Painting, Sculpture, Modelling, &c.
69. History of Hearing and Sound.
70. History of Music.
71. History of Smell and Smells.
72. History of Taste and Tastes.
73. History of Touch, and the objects of Touch.
74. History of Venus, as a species of Touch.
75. History of Bodily Pains, as species of Touch.
76. History of Pleasure and Pain in general.
77. History of the Affections; as Anger, Love, Shame, &c.
78. History of the Intellectual Faculties; Reflexion, Imagination, Discourse, Memory, &c.
79. History of Natural Divinations.
80. History of Diagnostics, or Secret Natural Judgments.

81. History of Cookery, and the arts thereto belonging, as of the Butcher, Poulterer, &c.
82. History of Baking, and the Making of Bread, and the arts thereto belonging, as of the Miller, &c.

83. History of Wine.
84. History of the Cellar and of different kinds of Drink.
85. History of Sweetmeats and Confections.
86. History of Honey.
87. History of Sugar.
88. History of the Dairy.
89. History of Baths and Ointments.
90. Miscellaneous History concerning the care of the body, — as of Barbers, Perfumers, &c.
91. History of the working of Gold, and the arts thereto belonging.
92. History of the manufactures of Wool, and the arts thereto belonging.
93. History of the manufactures of Silk, and the arts thereto belonging.
94. History of manufactures of Flax, Hemp, Cotton, Hair, and other kinds of Thread, and the arts thereto belonging.
95. History of manufactures of Feathers.
96. History of Weaving, and the arts thereto belonging.
97. History of Dyeing.
98. History of Leather-making, Tanning, and the arts thereto belonging.
99. History of Ticking and Feathers.
100. History of working in Iron.
101. History of Stone-cutting.
102. History of the making of Bricks and Tiles.
103. History of Pottery.
104. History of Cements, &c.
105. History of working in Wood.
106. History of working in Lead.

107. History of Glass and all vitreous substances, and of Glass-making.
108. History of Architecture generally.
109. History of Waggons, Chariots, Litters, &c.
110. History of Printing, of Books, of Writing, of Sealing; of Ink, Pen, Paper, Parchment, &c.
111. History of Wax.
112. History of Basket-making.
113. History of Mat-making, and of manufactures of Straw, Rushes, and the like.
114. History of Washing, Scouring, &c.
115. History of Agriculture, Pasturage, Culture of Woods, &c.
116. History of Gardening.
117. History of Fishing.
118. History of Hunting and Fowling.
119. History of the Art of War, and of the arts thereto belonging, as Armoury, Bow-making, Arrow-making, Musketry, Ordnance, Cross-bows, Machines, &c.
120. History of the Art of Navigation, and of the crafts and arts thereto belonging.
121. History of Athletics and Human Exercises of all kinds.
122. History of Horsemanship.
123. History of Games of all kinds.
124. History of Jugglers and Mountebanks.
125. Miscellaneous History of various Artificial Materials, — as Enamel, Porcelain, various Cements, &c.
126. History of Salts.
127. Miscellaneous History of various Machines and Motions.

128. Miscellaneous History of Common Experiments which have not grown into an Art.

Histories must also be written of Pure Mathematics; though they are rather observations than experiments.

129. History of the Natures and Powers of Numbers.

130. History of the Natures and Powers of Figures.

It may not be amiss to observe that, whereas many of the experiments must come under more titles than one (as the History of Plants and the History of the Art of Gardening have many things in common), it will be more convenient to investigate them with reference to Arts, and to arrange them with reference to Bodies. For I care little about the mechanical arts themselves: only about those things which they contribute to the equipment of philosophy. But these things will be better regulated as the case arises.

FINIS.

OF

THE DIGNITY AND ADVANCEMENT

OF

LEARNING.

BOOKS II. — IX.

THE

DIVISIONS OF THE SCIENCES,

AND

ARGUMENTS OF THE SEVERAL CHAPTERS.

BOOK THE SECOND.

CHAP. I.

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made to two Deficients; namely, the doctrine concerning the *Extension of the Bounds of Empire*, and the doctrine concerning *Universal Justice*, or the *Fountains of Law*.

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CHAP. I.

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OF

THE ADVANCEMENT OF LEARNING.

BOOK II.[1]

TO THE KING.

It might seem to have more convenience, excellent King, though it come often otherwise to pass, that those who are fruitful in their generations, and have as it were the foresight of immortality in their descendants, should likewise be more careful than other men of the good estate of future times, to which they know they must transmit these their dearest pledges. Queen Elizabeth, rather a sojourner in the world than an inhabitant, in respect of her unmarried life, was an ornament to her own times and prospered them in many ways. But to your Majesty (whom God in His goodness has already blessed with so much royal issue, worthy to continue and represent you for ever, and whose youthful and fruitful bed still promises more) it is proper and convenient not only to shed a lustre (as you do) on your own age, but also to extend your care

[1] For the first book (which relates to the Dignity of Learning), see Vol. VI. p. 87. The Latin differs so little from the English in that book, that a translation would be little else than a reprint. And the eight remaining books of the *De Augmentis Scientiarum*, considered as a treatise on the Divisions of the Sciences, are complete in themselves. — *J. S.*

to those things which all memory may preserve and which are in their nature eternal. Amongst which (if affection for learning transport me not) there is not any more noble or more worthy than the further endowment of the world with sound and fruitful knowledge. For how long shall we let a few received authors stand up like Hercules' columns, beyond which there shall be no sailing or discovery in science, when we have so bright and benign a star as your Majesty to conduct and prosper us?

To return then to the matter in hand: let us now review and consider with ourselves what has hitherto been done by kings and others for the increase and advancement of learning, and what has been left undone; and let us discuss the question solidly and distinctly, in a style active and masculine, without digressing or dilating. We may begin then by assuming (which will not be disputed) that all the greatest and most difficult works are overcome either by amplitude of reward, or by prudence and soundness of direction, or by conjunction of labours; whereof the first stimulates endeavour, the second removes uncertainty and error, and the third supplies the frailty of man. But of these three, prudence and soundness of direction, — that is, the pointing out and setting forth of the straight and ready way to the thing which is to be done, — must be placed first. For the cripple in the right way (as the saying is) outstrips the runner in the wrong. And Solomon observes, most aptly to the point in question, that "if the iron be blunt it requireth more strength, but wisdom is that which prevaileth;" signifying that the prudent choice of the mean is more effectual for the purpose than either the enforcement or

the accumulation of endeavours. This I am induced to say, for that (not derogating from the honour of those who have been in any way deservers towards the state of learning) I observe nevertheless that most of their works and acts have had in view rather their own magnificence and memory than the progress and advancement of learning, and have rather augmented the number of learned men than raised and rectified the sciences themselves.

The works or acts which pertain to the advancement of learning are conversant about three objects; the places of learning, the books of learning, and the persons of the learned. For as water, whether it be the dew of Heaven or the springs of the earth, easily scatters and loses itself in the ground, except it be collected into some receptacle where it may by union and consort comfort and sustain itself (and for that cause the industry of man has devised aqueducts, cisterns, and pools, and likewise beautified them with various ornaments, for magnificence and state as well as for use and necessity); so this excellent liquor of knowledge, whether it descend from divine inspiration or spring from human sense, would soon perish and vanish into oblivion, if it were not preserved in books, traditions, and conferences; and especially in places appointed for such matters, as universities, colleges, and schools, where it may have both a fixed habitation and means and opportunity of increasing and collecting itself.

And first, the works which concern the *places of learning* are four; buildings, endowments with revenues, grants of franchises and privileges, and institutions and ordinances of government; all tending (for the most part) to retirement and quietness of life, and

a release from cares and trouble; like the stations which Virgil prescribes for the hiving of honey bees.

> Principio sedes apibus statioque petenda,
> Quo neque sit ventis aditus, &c.[1]

The principal works touching *books* are two; first, libraries, which are as the shrines wherein all the relics of the ancient saints full of true virtue are preserved. Secondly, new editions of authors, with more correct impressions, more faithful translations, more profitable commentaries, more diligent annotations, and the like.

The works pertaining to the *persons of the learned* (besides the advancement and countenancing of them in general) are likewise two. The remuneration and designation of lecturers in arts already extant and invented; and the remuneration and appointment of writers and inquirers concerning those parts of learning not yet sufficiently laboured or prosecuted.

These are summarily the works and acts wherein the merits of many excellent princes and other illustrious personages towards learning have been manifested. As for the particular commemoration of any one who has deserved well of literature, I call to mind what Cicero said when, on his return from exile, he gave general thanks; "It is hard to remember all, ungrateful to pass by any."[2] Let us rather (after the advice of Scripture) look forward to that part of the race which is still to be run, than look back to that which has been passed.

First therefore, among so many noble foundations of colleges in Europe, I find it strange that they are all

[1] Virg. Georg. iv. 8.:— First for thy bees a quiet station find,
And lodge them under covert of the wind.

[2] Cicero, Post Red. c. 12.

dedicated to professions, and none left free to the study of arts and sciences at large. For if men judge that learning should be referred to use and action, they judge well; but it is easy in this to fall into the error pointed at in the ancient fable; in which the other parts of the body found fault with the stomach, because it neither performed the office of motion as the limbs do, nor of sense, as the head does; but yet notwithstanding it is the stomach which digests and distributes the aliment to all the rest. So if any man think that Philosophy and Universality are idle and unprofitable studies, he does not consider that all arts and professions are from thence supplied with sap and strength. And this I take to be a great cause, which has so long hindered the more flourishing progress of learning; because these fundamental knowledges have been studied but in passage, and not drunk deeper of. For if you will have a tree bear more fruit than it has used to do, it is not anything you can do to the boughs, but it is the stirring of the earth, and putting richer mould about the roots, that must work it. Neither is it to be forgotten that this dedication of colleges and societies to the use only of professory learning has not only been inimical to the growth of the sciences, but has also been prejudicial to states and governments. For hence it proceeds that princes when they have to choose men for business of state find a wonderful dearth of able men around them; because there is no collegiate education designed for these purposes, where men naturally so disposed and affected might (besides other arts) give themselves especially to histories, modern languages, books of policy and civil discourse; whereby they might come better prepared and instructed to offices of state.

And because founders of Colleges do plant, and founders of Lectures do water, I must next speak of the deficiencies which I find in public lectures; wherein I especially disapprove of the smallness of the salary assigned to lecturers in arts and professions, particularly amongst ourselves. For it is very necessary to the progression of sciences that lecturers in every sort be of the most able and sufficient men; as those who are ordained not for transitory use, but for keeping up the race and succession of knowledge from age to age. This cannot be, except their condition and endowment be such that the most eminent professors may be well contented and willing to spend their whole life in that function and attendance, without caring for practice. And therefore if you will have sciences flourish, you must observe David's military law; which was, "That those who stayed with the baggage should have equal part with those who were in the action;"[1] else will the baggage be ill attended. So lecturers in sciences are as it were the keepers and guardians of the whole store and provision of learning, whence the active and militant part of the sciences is furnished; and therefore they ought to have equal entertainment and profit with the men of active life. Otherwise if the fathers in sciences be not amply and handsomely maintained, it will come to pass, as Virgil says of horses,—

Et patrum invalidi referent jejunia nati;[2]

the poor keeping of the parents will be seen in the weakliness of the children.

I will now notice another defect, wherein I should call in some alchemist to help me; one of those who advise the studious to sell their books and build fur-

[1] 1 Sam. xxx. 24. [2] Georg. iii. 128.

naces, and forsaking Minerva and the Muses as barren virgins, to rely upon Vulcan. But certain it is that for depth of speculation no less than for fruit of operation in some sciences (especially natural philosophy and physic) other helps are required besides books. Wherein also the beneficence of men has not been altogether wanting; for we see spheres, globes, astrolabes, maps, and the like have been provided and prepared as assistants to astronomy and cosmography, as well as books. We see likewise that some places instituted for physic have gardens for the examination and knowledge of simples of all sorts, and are not without the use of dead bodies for anatomical observations. But these respect but a few things. In general, it may be held for certain that there will hardly be any great progress in the unravelling and unlocking of the secrets of nature, except there be a full allowance for expenses about experiments; whether they be experiments appertaining to Vulcan or Dædalus (that is, the furnace or engine), or any other kind. And therefore as secretaries and emissaries of princes are allowed to bring in bills of expenses for their diligence in exploring and unravelling plots and civil secrets, so the searchers and spies of nature must have their expenses paid, or else you will never be well informed of a great number of things most worthy to be known. For if Alexander made such a liberal assignation of money to Aristotle, to support hunters, fowlers, fishers and the like, that he might be better furnished for compiling a History of Animals; certainly much more do they deserve it, who instead of wandering in the forests of nature, make their way through the labyrinths of arts.

Another defect to be noticed (and one of great im-

portance) is a neglect of consultation in governors of universities, and of visitation in princes or superior persons, to enter into careful account and consideration whether the readings, disputations, and other scholastic exercises anciently begun, and since continued up to our time, may be profitably kept up, or whether we should rather abolish them and substitute better. For I find it is one of your Majesty's most wise maxims; "That in all usages or precedents the times be considered wherein they first began; which, if they were disordered or ignorant, it derogates greatly from the authority of the precedents, and leaves all things for suspect." And therefore inasmuch as most of the institutions of the universities are derived from times a good deal more obscure and ignorant than our own, it is the more convenient that they be re-examined. In this kind I will give an instance or two, of things which appear the most obvious and familiar. It is a general custom (and yet I hold it to be an error) that scholars come too soon and too unripe to the study of logic and rhetoric, arts fitter for graduates than children and novices; for these two rightly taken are the gravest of sciences, being the arts of arts, the one for judgment, the other for ornament; besides they give the rule and direction how both to set forth and illustrate the subject matter. And therefore for minds empty and ignorant (and which have not yet gathered what Cicero calls "stuff"[1] or "furniture,"[2] that is matter and variety) to begin with those arts (as if one should learn to weigh or to measure or to paint the wind), works but this effect, that the virtue and faculty of those arts (which are great and universal) are almost made con-

[1] *Sylva.* De Orator. iii. 26. [2] *Supellex.* Orator, c. 24.

temptible, and either degenerate into childish sophistry and ridiculous affectation, or at least lose not a little of their reputation. And further, the premature and untimely learning of these arts has drawn on, by consequence, the superficial and unprofitable teaching and handling of them, — a manner of teaching suited to the capacity of children. Another instance of an error which has long prevailed in universities is this; that they make too great and mischievous a divorce between invention and memory. For most of the speeches there are either entirely premeditate, and delivered in preconceived words, where nothing is left to invention; or merely extempore, where little is left to memory; whereas in common life and action there is little use of either of these separately, but rather of intermixtures of them; that is of notes or commentaries and extempore speech; and thus the exercise fits not the practice, nor the image the life. But it must ever be observed as a rule in exercises, that they be made to represent in everything (as near as may be) the real actions of life; for otherwise they will pervert the motions and faculties of the mind, and not prepare them. The truth whereof appears clearly enough when scholars come to the practice of their professions, or other offices of civil life; which when they set into, this want I speak of is soon found out by themselves, but still sooner by others. But this part, touching the amendment of the Institutions and Orders of Universities, I will conclude with a sentence taken from one of Cæsar's letters to Oppius and Balbus; "How this may be done, some means occur to me, and many may be found; I beg you therefore to take these matters into consideration."[1]

[1] Cic. Ep. ad Att. ix. 8.

Another defect which I note ascends a little higher than the preceding. For as the progress of learning consists not a little in the wise ordering and institutions of each several university; so it would be yet much more advanced if there were a closer connexion and relationship between all the different universities of Europe than now there is. For we see there are many orders and societies which, though they be divided under distant sovereignties and territories, yet enter into and maintain among themselves a kind of contract and fraternity, insomuch that they have governors (both provincial and general) whom they all obey. And surely as nature creates brotherhood in families, and arts mechanical contract brotherhoods in societies, and the anointment of God superinduces a brotherhood in kings and bishops, and vows and regulations make a brotherhood in religious orders; so in like manner there cannot but be a noble and generous brotherhood contracted among men by learning and illumination, seeing that God himself is called "the Father of Lights." [1]

The last defect I complain of (to which I have already alluded) is that there has not been, or very rarely been, any public designation of fit men either to write or to make inquiry concerning such parts of knowledge as have not been already sufficiently laboured. To which point it will greatly conduce, if a review and *census* be made of the sciences, and account be taken what parts of them are rich and well advanced, and what poor and destitute. For the opinion of plenty is amongst the causes of want; and the great quantity of books makes a show rather of superfluity than lack;

[1] St. James, i. 17.

of which surcharge nevertheless the true remedy is not to destroy the old books, but to make more good ones; of such a kind that like the serpent of Moses, they may devour the serpents of the enchanters.[1]

The removal of all the defects formerly enumerated, except the last, and of the active part also of the last, which relates to the designation of writers, are truly works for a king; towards which the endeavours and industry of a private man can be but as an image in a crossway, that may point at the way but cannot go it. But the speculative part of it, which relates to the survey of knowledges to see what in each is deficient, is open likewise to private industry. Wherefore I now intend to make a general and faithful perambulation and survey of learning, with a very careful and accurate inquiry what parts thereof lie fresh and waste, and not yet improved and converted to use by the industry of man; to the end that such a plot marked out, and recorded to memory, may minister light both to public designations and voluntary endeavours. Wherein nevertheless my purpose is at this time to note only omissions and deficiencies, and not to make any redargution of errors and failures; for it is one thing to point out what parts lie untilled, and another thing to mend the manner of tillage.

In addressing myself to which task I am not ignorant how great a work I attempt, and how difficult a province I take upon me; nor again how far unequal my strength is to my will. Nevertheless I have great hope that if my extreme love to learning carry me too far, I may obtain the excuse of affection; for that "it is not granted to any man at the same time to love and

[1] Not Moses, but Aaron. Ex. vii. 12.

to be wise."[1] But I know well I can use no other liberty of judgment, than I must leave to others; and I for my part shall be equally glad either to perform myself or to accept from others that duty of humanity, to put the wanderer on the right way: *nam qui erranti comiter monstrat viam*,[2] &c. I foresee likewise that many of those things which I shall think fit to enter in this registry of mine as omitted and deficient will incur censure on different accounts; some as being already done and extant; others as savouring of curiosity, and promising very scanty fruit; others as being too difficult and almost impossible to be compassed and effected by man. For the two first I refer myself to the particulars themselves. For the last, touching impossibility, I take it that all those things are to be held possible and performable, which may be done by some persons, though not by every one; and which may be done by many together, though not by one alone; and which may be done in the succession of ages, though not in one man's life; and lastly, which may be done by public designation and expense, though not by private means and endeavour. But notwithstanding if any man will take to himself rather the saying of Solomon, "The slothful man says there is a lion in the path,"[3] than that of Virgil, *Possunt, quia posse videntur*,[4] "they find it possible because they think it possible," I shall be content that my labours be esteemed but as the better sort of wishes. For as it asks some knowledge of a thing to demand a question not impertinent, so it requires some sense to make a wish not absurd.

[1] Senecæ Proverbia.
[2] Ennius, ap. Aul. Gell. xii. 4. and ap. Cic. De Officiis, i. 17.
[3] Prov. xxvi. 13.
[4] Virg. Æn. v. 231.

CHAPTER I.

The Division of all Human Learning into History, Poesy, Philosophy; *with reference to the three Intellectual Faculties*, — Memory, Imagination, *and* Reason; *and that the same division holds good likewise in* Theology.

THE best division of human learning is that derived from the three faculties of the rational soul, which is the seat of learning. History has reference to the Memory, poesy to the Imagination, and philosophy to the Reason. And by poesy here I mean nothing else than feigned history or fables; for verse is but a character of style, and belongs to the arts of speech, whereof I will treat in its proper place.

History is properly concerned with individuals, which are circumscribed by place and time. For though Natural History may seem to deal with species, yet this is only because of the general resemblance which in most cases natural objects of the same species bear to one another; so that when you know one, you know all. And if individuals are found, which are either unique in their species, like the sun and moon; or notable deviations from their species, like monsters; the description of these has as fit a place in Natural History as that of remarkable men has in Civil History. All this relates to the Memory.

Poesy, in the sense in which I have defined the word, is also concerned with individuals; that is, with individuals invented in imitation of those which are the subject of true history; yet with this difference, that it commonly exceeds the measure of nature, joining at

pleasure things which in nature would never have come together, and introducing things which in nature would never have come to pass; just as Painting likewise does. This is the work of Imagination.

Philosophy discards individuals; neither does it deal with the impressions immediately received from them, but with abstract notions derived from these impressions; in the composition and division whereof according to the law of nature and fact its business lies. And this is the office and work of Reason.

That these things are so, may be easily seen by observing the commencements of the intellectual process. The sense, which is the door of the intellect, is affected by individuals only. The images of those individuals — that is, the impressions which they make on the sense — fix themselves in the memory, and pass into it in the first instance entire as it were, just as they come. These the human mind proceeds to review and ruminate; and thereupon either simply rehearses them, or makes fanciful imitations of them, or analyses and classifies them. Wherefore from these three fountains, Memory, Imagination, and Reason, flow these three emanations, History, Poesy, and Philosophy; and there can be no others. For I consider history and experience to be the same thing, as also philosophy and the sciences.

Nor do I think that any other division is wanted for Theology. The information derived from revelation and the information derived from the sense differ no doubt both in the matter and in the manner of conveyance; but the human mind is the same, and its repositories and cells the same. It is only like different liquids poured through different funnels into one

and the same vessel. Theology therefore in like manner consists either of Sacred History, or of Parables, which are a divine poesy, or of Doctrines and Precepts, which are a perennial philosophy. For as for that part which seems supernumerary, which is Prophecy, it is but a kind of history: for divine history has this prerogative over human, that the narration may be before the event, as well as after.

CHAP. II.

The Division of History into Natural *and* Civil; Ecclesiastical *and* Literary *History being included in Civil. Division of Natural History into* History of Generations, Pretergenerations, *and* Arts.

History is either Natural or Civil. Natural History treats of the deeds and works of nature; Civil History of those of men. Matter of Divinity shows itself no doubt in both, but principally in the latter; so much so as to form a species of history proper to itself, which I call Sacred or Ecclesiastical. And a similar distinction is in my opinion also due to Learning and the Arts — their importance being such as to entitle them to a separate history of their own. And this (as well as the Ecclesiastical) I mean to be included in Civil History.

The division which I will make of Natural History is founded upon the state and condition of nature herself. For I find nature in three different states, and subject to three different conditions of existence. She is either free, and follows her ordinary course of devel-

opment; as in the heavens, in the animal and vegetable creation, and in the general array of the universe; or she is driven out of her ordinary course by the perverseness, insolence, and frowardness of matter, and violence of impediments; as in the case of monsters; or lastly, she is put in constraint, moulded, and made as it were new by art and the hand of man; as in things artificial. Let Natural History therefore be divided into the History of Generations, of Pretergenerations, and of Arts; which last I also call Mechanical and Experimental History. Of these the first treats of the Freedom of Nature, the second of her Errors, the third of her Bonds. And I am the more induced to set down the History of the Arts as a species of Natural History, because an opinion has long been prevalent, that art is something different from nature, and things artificial different from things natural; whence this evil has arisen, — that most writers of Natural History think they have done enough when they have given an account of animals or plants or minerals, omitting all mention of the experiments of mechanical arts. But there is likewise another and more subtle error which has crept into the human mind; namely, that of considering art as merely an assistant to nature, having the power indeed to finish what nature has begun, to correct her when lapsing into error, or to set her free when in bondage, but by no means to change, transmute, or fundamentally alter nature. And this has bred a premature despair in human enterprises. Whereas men ought on the contrary to be surely persuaded of this; that the artificial does not differ from the natural in form or essence, but only in the efficient; in that man has no power over nature except that of mo-

tion; he can put natural bodies together, and he can separate them; and therefore that wherever the case admits of the uniting or disuniting of natural bodies, by joining (as they say) actives with passives, man can do everything; where the case does not admit this, he can do nothing. Nor matters it, provided things are put in the way to produce an effect, whether it be done by human means or otherwise. Gold is sometimes refined in the fire and sometimes found pure in the sands, nature having done the work for herself. So also the rainbow is made in the sky out of a dripping cloud; it is also made here below with a jet of water. Still therefore it is nature which governs everything; but under nature are included these three; the *course* of nature, the *wanderings* of nature, and *art*, or nature with man to help; which three must therefore all be included in Natural History; as indeed they are in great measure by Pliny, the only person who ever undertook a Natural History according to the dignity of it; though he was far from carrying out his undertaking in a manner worthy of the conception.

The first of these, the history of nature in course, is extant, and that in moderate perfection; but the two latter are so weakly and unprofitably handled that they may be set down as deficient. For you will find no sufficient and competent collection of those works of nature which have a digression and deflexion from the ordinary course of generations, productions, and motions; whether they be singularities of place and region, or the strange events of time, or *casuum ingenia* (as they have been called) — devices of chance, or the effects of hidden properties, or productions of nature singular in their kind. It is true, I find books more

than enough filled with fabulous experiments, idle secrets, and frivolous impostures, for pleasure and novelty; but a substantial and methodical collection of the Heteroclites or Irregulars of nature well examined and described I find not; especially not with due rejection and as it were public proscription of fables and popular errors. For as things now are, if an untruth in nature once get a footing and be made common, what by reason of men's reverence for antiquity, what by reason of the troublesomeness of putting it to the test anew, and what by reason of the use of the opinion in similitudes and ornaments of speech, it is never overthrown or retracted.

The end of this work, honoured with a precedent in Aristotle, is nothing less than to gratify the appetite of curious and vain wits, as the manner of mirabilaries is to do; but for two reasons, both of great weight; the one to correct the partiality of axioms and opinions, which are framed for the most part upon common and familiar examples; the other, because from the wonders of nature is the most clear and open passage to the wonders of art. For you have but to follow and as it were hound nature in her wanderings, and you will be able, when you like, to lead and drive her afterwards to the same place again. Neither am I of opinion in this history of marvels, that superstitious narratives of sorceries, witchcrafts, charms, dreams, divinations, and the like, where there is an assurance and clear evidence of the fact, should be altogether excluded. For it is not yet known in what cases, and how far, effects attributed to superstition participate of natural causes; and therefore howsoever the use and practice of such arts is to be condemned, yet from the

speculation and consideration of them (if they be diligently unravelled) a useful light may be gained, not only for the true judgment of the offences of persons charged with such practices, but likewise for the further disclosing of the secrets of nature. Neither ought a man to make scruple of entering and penetrating into these holes and corners, when the inquisition of truth is his sole object, — as your Majesty has shown in your own example; who, with the two clear and acute eyes of religion and natural philosophy, have looked deeply and wisely into those shadows, and yet proved yourself to be truly of the nature of the sun, which passes through pollutions and is not defiled. I would recommend however that those narrations which are tinctured with superstition be sorted by themselves, and not mingled with those which are purely and sincerely natural. But as for narrations touching the prodigies and miracles of religions, they are either not true or not natural; and therefore impertinent for the story of nature.

For History of Nature Wrought, or Mechanical, as I also call it, I find some collections made of agriculture and likewise of many manual arts; but always (which is a great detriment in this kind of learning) with a neglect and rejection of experiments familiar and vulgar; which yet in the interpretation of nature are of equal, if not of more value than those which are less common. For it is esteemed a kind of dishonour upon learning for learned men to descend to inquiry or meditation upon matters mechanical; except they be such as may be thought secrets of art, or rarities and special subtleties. Which humour of vain and supercilious arrogancy is justly derided in Plato,

where he brings in Hippias, a vaunting Sophist, disputing with Socrates, a true and unfeigned inquisitor of truth; where, the discourse being touching beauty, Socrates, after his loose and wandering manner of inductions, put first an example of a fair virgin, then of a fair horse, then of a fair pot well glazed. Whereat Hippias was offended, and said, "Were it not for courtesy's sake, I should be loth to dispute with one that did allege such base and sordid instances." Whereunto Socrates answered, "You have reason, and it becomes you well, being a man so trim in your vestments, and so fairly shod;" and so goes on in irony. But the truth is, that they are not the highest instances, which give the best or securest information; as is expressed not inelegantly in the common story of the philosopher, who, while he gazed upwards to the stars, fell into the water; for if he had looked down he might have seen the stars in the water, but looking aloft he could not see the water in the stars. So it often comes to pass that mean and small things discover great better than great can discover small, and therefore it was well observed by Aristotle "that the nature of everything is best seen in its smallest portions." For which cause he inquires the nature of a commonwealth first in a family and the simplest conjugations of society — (man and wife, parent and child, master and servant) — which are present in every cottage.[1] Even so likewise the nature of this great city of the world, and the policy thereof, must be first sought in its primary concordances, and smallest portions; as we see that that secret of nature (esteemed one of the great mysteries) of the turning of iron touched with the loadstone to-

[1] Arist. Politica, i. 1.

wards the north, was found out not in bars of iron but in needles.

But if my judgment be of any weight, the use of History Mechanical is, of all others, the most radical and fundamental towards natural philosophy; such natural philosophy I mean as shall not vanish in the fumes of subtle or sublime speculations, but such as shall be operative to relieve the inconveniences of man's estate. For it will not only be of immediate benefit, by connecting and transferring the observations of one art to the use of others, and thereby discovering new commodities; a result which must needs follow when the experience of different arts shall fall under the observation and consideration of one man's mind; but further, it will give a more true and real illumination concerning the investigation of causes of things and axioms of arts, than has hitherto shone upon mankind. For like as a man's disposition is never well known or proved till he be crossed, nor Proteus ever changed shapes till he was straitened and held fast; so nature exhibits herself more clearly under the trials and vexations of art than when left to herself.

Before I dismiss this part of Natural History (which I call mechanical and experimental) I must add that the body of this kind of history should not be made up from the mechanical arts alone, but also from the operative part of the liberal sciences, as well as from many other practices which have not as yet grown up into arts; so as to omit nothing which may tend to inform the intellect. And this is the first division of Natural History.

CHAP. III.

The Second Division of Natural History, according to its Use and End, into Narrative *and* Inductive; *and that the noblest end of Natural History is to minister and be in order for the Foundation of Philosophy; which is the end aimed at in* Induction. *The Division of the History of Generations into the History of the* Heavenly Bodies, *the History of* Meteors, *the History of the* Globe of Earth and Sea, *the History of the* Masses *or* Greater Colleges, *and the History of the* Species *or* Lesser Colleges.

NATURAL History, which is threefold (as I said) in subject, is in use twofold. For it is used either for the sake of the knowledge of the things themselves that are committed to the history, or as the primary matter of philosophy. Now the first kind, which aims either to please by the agreeableness of the narrative or to help by the use of experiments, and is pursued for the sake of such pleasure or such profit, I account as far inferior in importance to that which is the stuff and material of a solid and lawful Induction, and may be called the nursing-mother of philosophy. Accordingly I shall now make a second division of Natural History into Narrative and Inductive; the latter whereof I set down as wanting. But let not any one be dazzled either by the great names of ancient philosophers or the great volumes of modern. For I well know that a natural history is extant, large in its bulk, pleasing in its variety, curious often in its diligence; but yet weed it of fables, antiquities, quotations, idle controversies, philology and ornaments (which are more fitted for table talk and the *noctes* of learned men than

for the instauration of philosophy), and it will shrink into a small compass. Certainly it is very different from that kind of history which I have in view. For in the first place there are wanting those two parts of natural history which I have just mentioned, Pretergenerations and Arts, of which I make great account; and next, in the third and remaining part, that of Generations, only one out of five parts is sufficiently handled. For the history of Generations is composed of five subordinate parts. First, a history of the *Celestial Bodies*, exhibiting the actual phenomena simply and apart from theories. Second, a history of *Meteors* (including comets), and what they call the *Regions of the Air;* for there is no history of comets, fiery meteors, winds, rains, storms, and the like, which is of any value. Third, a history of the *Earth and Sea* (considered as integral parts of the universe), mountains, rivers, tides, sands, woods, islands, and the shapes of continents as they lie; in all these, inquiring and observing rather the laws of nature than cosmography. Fourth, a history of the *Common Masses of Matter*, which I call the *Greater Colleges* (commonly called the *Elements*); for I find there are no accounts of fire, air, earth, and water, with their natures, motions, operations, and impressions, such as to form a just body of history. Fifth and last, a history of the *Exquisite Collections of Matter*, which I call the *Lesser Colleges*, but which are generally called *Species*. Now it is only in this last that writers have shown any conspicuous industry; and yet in such sort that they have rather filled it with things superfluous (as figures of animals, plants, and the like), than enriched it with sound and careful observations, which should ever be

annexed to natural history. And in a word all the natural history we have, whether in the mode of inquiry or in the matter collected, is quite unfit for the end which I have mentioned, namely, the Foundation of Philosophy. Wherefore I set down Inductive History as wanting. And so much for Natural History.

CHAP. IV.

The Division of Civil History into Ecclesiastical, Literary, *and* Civil (*which retains the name of the Genus*) *and that the History of* Literature *is wanting. Precepts for the Construction of it.*

Civil History may rightly be divided into three species. First, *Sacred* or *Ecclesiastical;* next, that which we call *Civil History* (using the generic name specially); lastly, the History of *Learning* and *the Arts.* I will begin with the kind last-mentioned; for the two former are extant, while the latter — the History of Learning — (without which the history of the world seems to me as the statue of Polyphemus without the eye; that very feature being left out which most marks the spirit and life of the person), I set down as wanting. Not but I know that in the particular sciences of the jurisconsults, mathematicians, rhetoricians, philosophers, we have some slight mention or some barren narrations about the sects, schools, books, authors, and successions belonging to them; also that there exist some meagre and unprofitable memoirs of the inventors of arts and usages; but I say that a com-

plete and universal History of Learning is yet wanting. Of this therefore I will now proceed to set forth the argument, the method of construction, and the use.

The *argument* is no other than to inquire and collect out of the records of all time what particular kinds of learning and arts have flourished in what ages and regions of the world; their antiquities, their progresses, their migrations (for sciences migrate like nations) over the different parts of the globe; and again their decays, disappearances, and revivals. The occasion and origin of the invention of each art should likewise be observed; the manner and system of transmission, and the plan and order of study and practice. To these should be added a history of the sects, and the principal controversies in which learned men have been engaged, the calumnies to which they have been exposed, the praises and honours by which they have been rewarded; an account of the principal authors, books, schools, successions, academies, societies, colleges, orders,—in a word, everything which relates to the state of learning. Above all things (for this is the ornament and life of Civil History), I wish events to be coupled with their causes. I mean, that an account should be given of the characters of the several regions and peoples; their natural disposition, whether apt and suited for the study of learning, or unfitted and indifferent to it; the accidents of the times, whether adverse or propitious to science; the emulations and infusions of different religions; the enmity or partiality of laws; the eminent virtues and services of individual persons in the promotion of learning, and the like. Now all this I would have handled in a historical way, not wasting time, after the manner of critics, in praise and blame,

but simply narrating the fact historically, with but slight intermixture of private judgment.

For the *manner* of compiling such a history I particularly advise that the matter and provision of it be not drawn from histories and commentaries alone; but that the principal books written in each century, or perhaps in shorter periods, proceeding in regular order from the earliest ages, be themselves taken into consultation; that so (I do not say by a complete perusal, for that would be an endless labour, but) by tasting them here and there, and observing their argument, style, and method, the Literary Spirit of each age may be charmed as it were from the dead.

With regard to the *use* of the work, it is not so much to swell the honour and pomp of learning with a profusion of images; nor because out of my exceeding love for learning I wish the inquiry, knowledge, and preservation of everything that relates thereto to be pursued even to curiosity; but chiefly for a purpose more serious and important; which, in a word, is this: I consider that such a history as I have described, would very greatly assist the wisdom and skill of learned men in the use and administration of learning; that it would exhibit the movements and perturbations, the virtues and vices, which take place no less in intellectual than in civil matters; and that from the observation of these the best system of government might be derived and established. For the works of St. Ambrose or St. Augustine will not make so wise a bishop or divine as a diligent examination and study of Ecclesiastical History; and the History of Learning would be of like service to learned men. For everything is subject to chance and error which is not sup-

ported by examples and experience. And so much for the History of Learning.

CHAP. V.

On the Dignity and Difficulty of Civil History.

I COME next to *Civil History*, properly so called, whereof the dignity and authority are pre-eminent among human writings. For to its fidelity are entrusted the examples of our ancestors, the vicissitudes of things, the foundations of civil policy, and the name and reputation of men. But the difficulty is no less than the dignity. For to carry the mind in writing back into the past, and bring it into sympathy with antiquity; diligently to examine, freely and faithfully to report, and by the light of words to place as it were before the eyes, the revolutions of times, the characters of persons, the fluctuations of counsels, the courses and currents of actions, the bottoms of pretences, and the secrets of governments; is a task of great labour and judgment — the rather because in ancient transactions the truth is difficult to ascertain, and in modern it is dangerous to tell. Hence Civil History is beset on all sides with faults; some (and these are the greater part) write only barren and commonplace narratives, a very reproach to history; others hastily and disorderly string together a few particular relations and trifling memoirs; others merely run over the heads of events: others, on the contrary, go into all the minutest particularities, and such as have no rela-

tion to the main action; some indulge their imaginations in bold inventions; while others impress on their works the image not so much of their minds as of their passions, ever thinking of their party, but no good witnesses as to facts; some are always inculcating their favourite political doctrines, and idly interrupting the narrative by going out of the way to display them; others are injudiciously prolix in reporting orations and harangues, and even in relating the actions themselves; so that, among all the writings of men, there is nothing rarer than a true and perfect Civil History. But my present purpose in this division of learning is to mark omissions, and not to censure faults. I will now pursue the divisions of Civil History, and those of the different kinds; for the species will be exhibited more clearly under several heads, than under one head curiously traced through all its members.

CHAP. VI.

The First Division of Civil History into Memorials, Antiquities, *and* Perfect History.

Civil History is of three kinds, not unfitly to be compared with the three kinds of pictures or images. For of pictures and images we see some are unfinished, and wanting the last touch; some are perfect; and some are mutilated and defaced by age. So Civil History (which is a kind of image of events and times) may be divided into three kinds, corresponding to these, — *Memorials*, *Perfect History*, and *Antiquities*.

For Memorials are history unfinished, or the first rough draughts of history; and Antiquities are history defaced, or remnants of history which have casually escaped the shipwreck of time.

Memorials, or Preparatory History, are of two sorts, whereof the one may be termed *Commentaries*, the other *Registers*. Commentaries set down a bare continuance and tissue of actions and events without the causes and pretexts, the commencements and occasions, the counsels and orations, and other passages of action. For this is the true nature of a commentary, though Cæsar, in modesty mixed with greatness, chose to apply the name of a commentary to the best history extant. But Registers have a twofold character; for they either contain titles of things and persons in order of time, such as are called Annals and Chronologies; or collections of public acts, such as edicts of princes, decrees of councils, judicial proceedings, public speeches, letters of state, and the like, without a perfect continuance or contexture of the thread of the narration.

Antiquities, or remnants of histories, are (as was said) like the spars of a shipwreck; when, though the memory of things be decayed and almost lost, yet acute and industrious persons, by a certain persevering and scrupulous diligence, contrive out of genealogies, annals, titles, monuments, coins, proper names and styles, etymologies of words, proverbs, traditions, archives and instruments as well public as private, fragments of histories scattered about in books not historical, — contrive, I say, from all these things or some of them, to recover somewhat from the deluge of time: a work laborious indeed, but agreeable to men, and joined with a kind of reverence; and well worthy to

supersede the fabulous accounts of the origins of nations, and to be substituted for fictions of that kind; entitled however to the less authority, because in things which few people concern themselves about, the few have it their own way.

In these kinds of Imperfect History I think no deficiency is to be assigned; for they are things, as it were, imperfectly compounded, and therefore any deficiency in them is but their nature. As for epitomes (which are certainly the corruptions and moths of histories) I would have them banished, whereto likewise most men of sound judgment agree, as being things that have fretted and corroded the bodies of many most excellent histories, and wrought them into base and unprofitable dregs.

CHAP. VII.

The Division of Perfect History into Chronicles, Lives, *and* Relations; *and the Explanation thereof.*

But *Perfect History* is of three kinds, according to the object which it propounds for representation. For it either represents a portion of time, or a person worthy of mention, or an action or exploit of the nobler sort. The first we call Chronicles or Annals; the second, Lives; the third, Narrations or Relations. Of these the first excels in estimation and glory; the second, in profit and examples; and the third in verity and sincerity. For History of Times represents the magnitude of public actions, and the public faces and

deportments of persons, but omits and covers up in silence the smaller passages and motions of men and matters. But such being the workmanship of God, that he hangs the greatest weights upon the smallest wires, it comes commonly to pass that such a history, pursuing the greater things alone, rather sets forth the pomp and solemnity of business than the true and inward springs and resorts thereof. Moreover, when it does add and insert the counsels and motives, yet from its love of grandeur it introduces into human actions more gravity and prudence than they really have; so that a truer picture of human life may be found in a satire than in some histories of this kind. Whereas Lives, if they be well and carefully written (for I do not speak of elogies and barren commemorations of that sort), propounding to themselves a single person as their subject, in whom actions both trifling and important, great and small, public and private, must needs be united and mingled, certainly contain a more lively and faithful representation of things, and one which you may more safely and happily take for example in another case. But special Narrations and Relations of actions (as the Peloponnesian War, the Expedition of Cyrus, the Conspiracy of Catiline, and the like) cannot but be more purely and exactly true than the Perfect Histories of Times; because they may choose a manageable and definite argument, whereof a perfect knowledge and certainty and full information may be had; whereas the story of a time (especially if it be of a period much before the age of the writer) is sure to meet with many gaps in the records, and to contain empty spaces which must be filled up and supplied at pleasure by wit and conjecture. But this

which I say touching the sincerity of Relations, must be taken with reservation; for (seeing that everything human is subject to imperfection, and good is almost always associated with evil) it must certainly be confessed that relations of this kind, especially if published near the time of the actions themselves (being commonly written either in favour or in spite), are of all other histories the most to be suspected. But then again the evil carries this remedy along with it; that as these very relations are commonly put forth not by one side only, but by both, according to their several factions and parties, a way may be found to truth between the extremes on either hand; and after party heat has cooled down, a good and prudent historian will obtain from them no bad materials and provision for a more perfect history.

With regard to the deficiencies of these three kinds of history, it is certain that there are many particular histories (I speak of such as may be of some moderate worth and dignity) which have been hitherto neglected, with the greatest detriment to the honour and name of the kings and states to which they belong; though to mention them would take too much time. But leaving the care of foreign stories to foreign states (for I will not be a meddler in other nations' matters), I cannot fail to represent to your Majesty the unworthiness of the history of England as we now have it, in the main continuance thereof, and the partiality and obliquity of that of Scotland, in the latest and largest author that I have seen; supposing that it would be honour for your Majesty, and a work very acceptable to future ages, if this island of Great Britain, as it is now joined in one monarchy for the ages to come, so were joined

in one history for the ages past; after the manner of the Sacred History, which draws down the story of the ten tribes and of the two tribes as twins together. And if it shall seem that the greatness of this work (and great and difficult it is) may prevent it from being exactly and worthily performed, there is a memorable period of a much smaller compass of time, as to the history of England; that is to say, from the Union of the Roses to the Union of the Kingdoms; a portion of time wherein to my understanding there has been a greater variety of strange events than in like number of successions of any hereditary monarchy has ever been known. For it begins with the mixed obtaining of a crown, partly by arms, partly by title; an entry by battle, an establishment by marriage; and therefore times corresponding to these beginnings, like waters after a tempest, full of working and swelling, though without extremity of storm; but well passed through by the wisdom of the pilot, who was the most conspicuous for policy of all the kings who preceded him. Then follows the reign of a king whose actions, though conducted more by impulse than policy, exercised no slight influence over the affairs of Europe; balancing and inclining them variably. In whose reign also begun that great alteration in the State Ecclesiastical, an action which seldom comes upon the stage. Then the reign of a minor. Then an attempt at a usurpation, though it was but as a diary ague. Then the reign of a queen matched with a foreigner; then of a queen that lived solitary and unmarried. And now, last, this most happy and glorious event, that this island of Britain, divided from all the world, should be united in itself, and that old oracle given to Æneas

(Antiquam exquirite matrem[1]), which foreshowed the rest in store for him, should now be performed and fulfilled upon the most renowned nations of England and Scotland; being now reunited in the ancient mother name of Britain, as a pledge and token of the end and period of all instability and peregrinations; so that as it comes to pass in massive bodies, that they have certain trepidations and waverings before they fix and settle; so it seems to have been ordained by the providence of God that this monarchy, before it settled and was confirmed in your Majesty and your royal generations (in which I hope it is now established for ever), should undergo these prelusive changes and varieties.

For Lives, I find it strange, when I think of it, that these our times have so little esteemed their own virtues, as that the commemoration and writing of the lives of those who have adorned our age should be no more frequent. For although there be but few sovereign kings or absolute commanders, and not many princes in free states (so many free states being now turned into monarchies), yet are there many worthy personages (even living under kings) that deserve better than dispersed report or dry and barren eulogy. For herein, the invention of one of the later poets, by which he has enriched the ancient fiction, is not inelegant. He feigns that at the end of the thread or web of every man's life there hangs a little medal or collar, on which his name is stamped; and that Time waits upon the shears of Atropos, and as soon as the thread is cut, snatches the medals, carries them off, and presently throws them into the river Lethe; and about the river there are many birds flying up and down, who catch

[1] Seek out your ancient mother. Virg. Æn. iii. 96.

the medals, and after carrying them round and round in their beak a little while, let them fall into the river; only there are a few swans, which if they get a medal with a name immediately carry it off to a temple consecrated to immortality.[1] Now this kind of swan is for the most part wanting in our age. And although there are many men, more mortal in their cares and desires than in their bodies, who regard the desire of name and memory but as a vanity and ventosity,

Animi nil magnæ laudis egentes;[2]

whose philosophy and severity springs no doubt from that root "Non prius laudes contempsimus, quam laudanda facere desivimus"[3] — yet that will not alter Solomon's judgment, "The memory of the just is praised, but the name of the wicked shall rot."[4] The one flourishes for ever; the other either consumes to present oblivion, or turns to an ill odour. And therefore in that style or form of words which is well appropriated to the dead — (of happy memory, of pious memory, of blessed memory), — we seem to acknowledge that which Cicero says (having borrowed it from Demosthenes), "That good fame is the only possession a dead man has;"[5] which possession I cannot but note that in our times it lies in most part waste and neglected.

For *Narrations* and *Relations*, a greater diligence therein is also much to be wished; for there is hardly

[1] Ariosto, *Orlando Furioso*, at the end of the 34th and beginning of the 35th Books.

[2] "Souls that care not for praise." — *Virg. Æn.* v. 751.

[3] "When we have ceased to do things deserving of praise we find that praise is an idle thing." — *Plin. Ep.* iii. 91.

[4] Prov. x. 7.

[5] Cf. Cicero, Philipp. ix., and Demos. λογ. επιταφ., 1389, 10.

any great action which is not attended by some good pen that can describe it. And because it is an ability not common to write a perfect history as it ought to be written (as may well appear from the small number even of moderate historians), yet if particular actions were but tolerably reported as they pass, it might be expected that a writer would some time or other arise who by such help and assistance might compile a complete History of Times. For the collection of such Relations would be as a nursery, whereby to plant a fair and stately garden when time should serve.

CHAP. VIII.

The Division of the History of Times into History Universal and Particular — *their Advantages and Disadvantages.*

HISTORY of Times is either Universal or Particular; whereof the latter contains the deeds of some kingdom, commonwealth, or people; the former those of the whole world. For there have been those who have affected to write the history of the world from its very beginning; exhibiting by way of history a medley of things and abridgments of narratives. Others have attempted to comprise, as in a perfect history, the memorable events of their own age all over the world; with noble enterprise, and no small result. For the affairs of men are not so far separated by the divisions of empires or countries, but they have a connexion in many things; and therefore it is certainly

of use to have the fates, acts, and destinies of one age described and contained as it were on one tablet. It is true also that many writings of no contemptible character (such as are those Relations of which I previously spoke), which would otherwise perish and not be reprinted, — that these, or at all events the principal matters in them, find a place in a general history of this kind, and in this way are fixed and preserved. But if due attention be paid to the subject, it will be found that the laws of regular history are so strict, that they can scarce be observed in such a wide field of matter; so that the dignity of history is rather diminished than increased by the greatness of the mass of it. For the writer who has such a variety of things on all sides to attend to, will become gradually less scrupulous on the point of information; his diligence, grasping at so many subjects, will slacken in each; he will take up with rumours and popular reports, and thus construct his history from relations which are not authentic, or other frivolous materials of the kind. He will be obliged moreover (lest the work increase beyond measure) purposely to omit a number of things worthy of record, and often to sink into abridgments. He is liable likewise to another danger, not small, and diametrically opposed to the very utility which belongs to Universal History; for as Universal History preserves some narrations which would perhaps otherwise perish, so on the other hand it destroys many that are profitable enough in themselves and would otherwise live, for the sake of that compendious brevity of which men are so fond.

CHAP. IX.

Another Division of the History of Times into Annals *and* Journals.

THE History of Times is also rightly divided into *Annals* and *Journals;* which division, though it takes its name from periods of time, yet has also reference to the choice of subjects. For it is well observed by Cornelius Tacitus, after touching upon the magnificence of certain buildings, "That it was found suitable to the dignity of the Roman people to commit to Annals only matters of note, but such things as these to the Journals of the City;"[1] thus referring matters concerning the state to Annals, but the less important kind of actions or accidents to Journals. Certainly, in my judgment, there ought to be a kind of heraldry in arranging the precedence of books, no less than of persons. For as nothing derogates from the dignity of a state more than confusion of ranks and degrees, so it not a little embases the authority of a history to intermingle matters of lighter moment, such as triumphs, ceremonies, spectacles, and the like, with matters of state. And surely it were to be wished that this distinction came into fashion. But in our times journals are only used in sea-voyages and expeditions of war; whereas in ancient times it was a matter of honour with princes to keep journals of what passed day by day in their courts; as we see in the case of Ahasuerus, King of Persia, who, when he could not take rest, called for the Chronicles, where he read over again the account of the conspiracy of the Eunuchs.[2]

[1] Tac. Ann. xiii. 31. [2] Esther, vi. 1.

But the journals of Alexander's house expressed every small particularity, so that even if he happened to sleep at table it was registered.[1] Not that, as none but grave matters were included in the Annals, so none but trifling ones were admitted into Journals; but everything, whether of greater or less concern, was promiscuously entered in the Journals as it passed.

CHAP. X.

The Second Division of Civil History into Pure *and* Mixed.

THE last division of Civil History is into *Pure* and *Mixed.* Of the Mixed there are two principal kinds; the one taken from Civil Science, the other principally from Natural. For some men have introduced a form of writing consisting of certain narratives not woven into a continuous history, but separate and selected according to the pleasure of the author; which he afterwards reviews, and as it were ruminates over, and takes occasion from them to make politic discourse and observation. Now this kind of Ruminated History I greatly approve, provided that the writer keep to it and profess it. But for a man who is professedly writing a Perfect History to be everywhere introducing political reflexions, and thereby interrupting the narrative, is unseasonable and wearisome. For though every wise history is pregnant (as it were) with political precepts and warnings, yet the writer himself should not play the midwife.

[1] Plut. Symp. i. 6.

Another kind of Mixed History is the History of Cosmography; which is indeed mixed of many things; of Natural History, in respect of the regions themselves, their sites and products; of History Civil, in respect of the habitations, governments, and manners of the people; and of Mathematics, in respect of the climates and configurations of the heavens, beneath which the regions of the world lie. In which kind of history or science we may congratulate our own age. For this great building of the world has in our age been wonderfully opened and thorough-lighted; and though the ancients had knowledge of the zones and the antipodes,

> Nosque ubi primus equis oriens afflavit anhelis,
> Illic sera rubens accendit lumina Vesper,[1]

yet that might be by demonstration rather than by travel. But for a little vessel to emulate the heaven itself, and to circle the whole earth with a course even more oblique and winding than that of the heavenly bodies, is the privilege of our age; so that these times may justly bear in their motto not only *plus ultra*—further yet—in precedence of the ancient *non ultra*—no further; and "Imitable Thunder" in precedence of the ancient "Inimitable Thunder,"

> (Demens qui nimbos, et non imitabile fulmen, &c.)[2]

but likewise, that which exceeds all admiration, "Imitable Heaven," in respect of our sea-voyages, by which the whole globe of earth has, after the manner of the heavenly bodies, been many times compassed and circumnavigated.

[1] And while on us the early morning breathes
With panting horses, there the blushing eve
Lights up her tardy signals.

[2] Virg. Æn. vi. 590.

And this proficience in navigation and discovery may plant also great expectation of the further proficience and augmentation of the sciences; especially as it may seem that these two are ordained by God to be coevals, that is, to meet in one age. For so the Prophet Daniel, in speaking of the latter times, foretells "That many shall go to and fro on the earth, and knowledge shall be increased,"[1] as if the opening and thorough passage of the world, and the increase of knowledge, were appointed to be in the same age; as we see it is already performed in great part; the learning of these our times, not much giving place to the two former periods or returns of learning (the one of the Grecians, the other of the Romans), but in some respects far exceeding them.

CHAP. XI.

The Division of Ecclesiastical History into Ecclesiastical History Special, History of Prophecy, *and* History of Providence.

History Ecclesiastical receives nearly the same divisions as History Civil; for there are Ecclesiastical Chronicles, there are Lives of the Fathers, there are Relations of Synods and other things pertaining to the Church. But in itself it is properly divided into *History Ecclesiastical* (using the general name in a special sense), *History of Prophecy*, and *History of Divine Judgments or Providence.* The first describes the times of the Church Militant, and its different states;

[1] Daniel, xii. 4.

whether fluctuant, as the ark of Noah; or moveable, as the ark in the wilderness; or at rest, as the ark in the Temple; that is, the state of the Church in persecution, in remove, and in peace. In this part I find no deficiency, but rather superfluities; only I would that the virtue and sincerity of the relations were in accordance with the mass and quantity of the matter.

The second, which is History of Prophecy, consists of two relatives, the Prophecy and the Accomplishment; and therefore the plan of such a work ought to be, that every prophecy of Scripture be sorted with the event fulfilling the same, throughout all ages of the world; both for the better confirmation of faith, and for better instruction and skill in the interpretation of those parts of prophecies which are yet unfulfilled; allowing nevertheless that latitude which is agreeable and familiar to divine prophecies, that the fulfilments of them are taking place continually, and not at the particular time only. For they are of the nature of their Author, "to whom a thousand years are but as one day, and one day as a thousand years;"[1] and though the height or fulness of them is commonly referred to some one age or particular period, yet they have at the same time certain gradations and processes of accomplishment through divers ages of the world. This is a work which I find deficient, but it is one that is to be done with great wisdom, sobriety, and reverence, or not at all.

The third part, which is History of Providence, has indeed been handled by the pens of some pious writers, but not without partiality. Its business is to observe that divine correspondence which sometimes exists be-

[1] Psalm xc. 4., and 2 Pet. iii. 8.

tween God's revealed and secret will. For though the judgments and counsels of God are so obscure that to the natural man they are altogether inscrutable, yea, and many times hidden from the eyes of those that behold them from the tabernacle, yet at some times it pleases the Divine Wisdom, for the better establishment of his people and the confusion of those who are as without God in the world, to write it and report it to view in such capital letters that (as the Prophet saith) "He that runneth by may read it;"[1] that is, that mere sensual persons and voluptuaries, who hasten by God's judgments, and never bend or fix their thoughts upon them, are nevertheless, though running fast and busy about other things, forced to discern them. Such are late and unlooked for judgments; deliverances suddenly and unexpectedly vouchsafed; divine counsels, through tortuous labyrinths and by vast circuits, at length manifestly accomplishing themselves; and the like; all which things serve not only to console the minds of the faithful, but to strike and convince the consciences of the wicked.

CHAP. XII.

Of the Appendices to History; which deal with the Words of Men (as History itself deals with their Actions). The Division thereof into Orations, Letters, *and* Apophthegms.

But not only man's *actions*, but his *words* also should be recorded. And these are no doubt some-

[1] Habakkuk, ii. 2.

times inserted in history itself, so far as they contribute to the perspicuity and weight of the narrative. But the sayings or words of men are properly preserved in books of *Speeches*, *Letters*, and *Apophthegms*. Certainly the Speeches of wise men on business and matters of grave and deep importance conduce greatly as well to the knowledge of the things themselves as to eloquence. But for instruction in civil prudence, still greater help is derived from Letters written by great men on weighty subjects. For of all the words of man nothing is more solid and excellent than letters of this kind; for they are more natural than orations, and more advised than conferences on the sudden. And when there is a continued series of them in order of time (as we find in the letters of ambassadors, governors of provinces, and other ministers of state, to kings, senates, and other superior officers; or, again, in the letters of rulers to their agents), they are of all others the most valuable materials for history. Neither are Apophthegms themselves only for pleasure and ornament, but also for use and action. For they are (as was said) "words which are as goads," words with an edge or point, that cut and penetrate the knots of business and affairs. Now occasions are continually returning, and what served once will serve again; whether produced as a man's own or cited as an old saying. Nor can there be any question of the utility in civil matters of that which Cæsar himself thought worthy of his labour; whose book of Apophthegms I wish were extant; for all the collections which we have of this kind appear to me to have been compiled without much judgment.

And so much concerning History; which is that

part of learning which answers to one of the cells, domiciles, or offices of the mind of man, which is that of the Memory.

CHAP. XIII.

On the second principal part of Learning, namely, Poesy. The Division of Poesy into Narrative, Dramatic, *and* Parabolical. *Three Examples of Parabolical Poesy are propounded.*

I NOW come to Poesy, which is a part of learning in measure of words for the most part restrained, but in all other points extremely free and licensed; and therefore (as I said at first) it is referred to the Imagination, which may at pleasure make unlawful matches and divorces of things. Now Poesy (as I have already observed) is taken in two senses; in respect of words or matter. In the first sense it is but a character of speech; for verse is only a kind of style and a certain form of elocution, and has nothing to do with the matter; for both true history may be written in verse and feigned history in prose. But in the latter sense, I have set it down from the first as one of the principal branches of learning, and placed it by the side of history; being indeed nothing else but an imitation of history at pleasure. And therefore, endeavouring as I do in these divisions to trace out and pursue the true veins of learning, without (in many points) following custom and the divisions which are received, I dismiss from the present discourse Satires, Elegies, Epigrams, Odes, and the like; and refer them to philosophy and

arts of speech. And under the name of Poesy, I treat only of feigned history.

The division of Poesy which is aptest and most according to the propriety thereof, besides those divisions which it has in common with History (for there are feigned Chronicles, feigned Lives, and feigned Relations), is into Poesy *Narrative*, *Dramatic*, and *Parabolical*. Narrative Poesy is a mere imitation of History, such as might pass for real, only that it commonly exaggerates things beyond probability. Dramatic Poesy is as History made visible; for it represents actions as if they were present, whereas History represents them as past. Parabolical Poesy is typical History, by which ideas that are objects of the intellect are represented in forms that are objects of the sense.

As for Narrative Poesy, — or Heroical, if you like so to call it (understanding it of the matter, not of the verse) — the foundation of it is truly noble, and has a special relation to the dignity of human nature. For as the sensible world is inferior in dignity to the rational soul, Poesy seems to bestow upon human nature those things which history denies to it; and to satisfy the mind with the shadows of things when the substance cannot be obtained. For if the matter be attentively considered, a sound argument may be drawn from Poesy, to show that there is agreeable to the spirit of man a more ample greatness, a more perfect order, and a more beautiful variety than it can anywhere (since the Fall) find in nature. And therefore, since the acts and events which are the subjects of real history are not of sufficient grandeur to satisfy the human mind, Poesy is at hand to feign acts more heroical; since the successes and issues of actions as related in

true history are far from being agreeable to the merits of virtue and vice, Poesy corrects it, exhibiting events and fortunes as according to merit and the law of providence; since true history wearies the mind with satiety of ordinary events, one like another, Poesy refreshes it, by reciting things unexpected and various and full of vicissitudes. So that this Poesy conduces not only to delight but also to magnanimity and morality. Whence it may be fairly thought to partake somewhat of a divine nature; because it raises the mind and carries it aloft, accommodating the shows of things to the desires of the mind, not (like reason and history) buckling and bowing down the mind to the nature of things. And by these charms, and that agreeable congruity which it has with man's nature, accompanied also with music, to gain more sweet access, it has so won its way as to have been held in honour even in the rudest ages and among barbarous peoples, when other kinds of learning were utterly excluded.

Dramatic Poesy, which has the theatre for its world, would be of excellent use if well directed. For the stage is capable of no small influence both of discipline and of corruption. Now of corruptions in this kind we have enough; but the discipline has in our times been plainly neglected. And though in modern states play-acting is esteemed but as a toy, except when it is too satirical and biting; yet among the ancients it was used as a means of educating men's minds to virtue. Nay, it has been regarded by learned men and great philosophers as a kind of musician's bow by which men's minds may be played upon. And certainly it is most true, and one of the great secrets of nature, that the minds of men are more open to impressions and

affections when many are gathered together than when they are alone.

But Parabolical Poesy is of a higher character than the others, and appears to be something sacred and venerable; especially as religion itself commonly uses its aid as a means of communication between divinity and humanity. But this too is corrupted by the levity and idleness of wits in dealing with allegory. It is of double use and serves for contrary purposes; for it serves for an infoldment; and it likewise serves for illustration. In the latter case the object is a certain method of teaching, in the former an artifice for concealment. Now this method of teaching, used for illustration, was very much in use in the ancient times. For the inventions and conclusions of human reason (even those that are now common and trite) being then new and strange, the minds of men were hardly subtle enough to conceive them, unless they were brought nearer to the sense by this kind of resemblances and examples. And hence the ancient times are full of all kinds of fables, parables, enigmas, and similitudes; as may appear by the numbers of Pythagoras, the enigmas of the Sphinx, the fables of Æsop, and the like. The Apophthegms too of the ancient sages commonly explained the matter by similitudes. Thus Menenius Agrippa among the Romans (a nation at that time by no means learned) quelled a sedition by a fable. In a word, as hieroglyphics were before letters, so parables were before arguments. And even now, and at all times, the force of parables is and has been excellent; because arguments cannot be made so perspicuous nor true examples so apt.

But there remains yet another use of Poesy Para-

bolical, opposite to the former; wherein it serves (as I said) for an infoldment; for such things, I mean, the dignity whereof requires that they should be seen as it were through a veil; that is when the secrets and mysteries of religion, policy, and philosophy are involved in fables or parables. Now whether any mystic meaning be concealed beneath the fables of the ancient poets is a matter of some doubt. For my own part I must confess that I am inclined to think that a mystery is involved in no small number of them. Nor does the fact that they are left commonly to boys and grammarians, and held in slight repute, make me despise them; but rather, since it is evident that the writings in which these fables are related are, next to sacred story, the most ancient of human writings, and the fables themselves still more ancient (for they are related not as being invented by the writers, but as things believed and received from of old), I take them to be a kind of breath from the traditions of more ancient nations, which fell into the pipes of the Greeks. But since that which has hitherto been done in the interpretation of these parables, being the work of unskilful men, not learned beyond common places, does not by any means satisfy me, I think fit to set down Philosophy according to the Ancient Parables among the *desiderata*. Of which work I will subjoin one or two examples; not so much perhaps for the value of the thing as for the sake of carrying out my principle; which is this; whenever I set down a work among the desiderata (if there be anything obscure about it), I intend always to set forth either instructions for the execution of it, or an example of the thing; else it might be thought that it was merely some light notion

that had glanced through my mind; or that I am like an augur measuring countries in thought, without knowing the way to enter them. I can report no other deficiency in Poesy; for being as a plant which comes from the lust of the earth without a formal seed, it has sprung up and spread abroad more than any other kind of learning. But I will now propound the examples, only three in number; one taken from things Natural, one from things Political, and one from things Moral.

The First Example of Philosophy according to the Fables of the Ancients, in Natural Philosophy. Of the Universe, *according to the Fable of* Pan.

THE ancients leave the parentage of Pan uncertain. Some call him the son of Mercury; others attribute to him a very different mode of generation, affirming that he sprang from the promiscuous intercourse of Penelope with all the suitors. There is also a third account, which must not be omitted; for some have declared that he was the son of Jupiter and Hybris (which signifies Contumely). Whatever his origin, the Fates are said to have been his sisters; who dwelt in a cave underground; while he himself lived in the open air. The person of Pan is described by ancient tradition as follows: — horns on his head, rising to a point and reaching up to heaven; his whole body rough and shaggy; his beard especially long; his figure biform, the upper part human, the lower part like a beast and ending in goat's feet. He carried as insignia of his office, in his left hand a pipe compact of seven reeds, in his right a shepherd's crook or staff, curved and bent at the upper end. His dress was a mantle of leopard's

skin. The titles and offices attributed to him were these; he was the god of hunters; also of shepherds, and of all persons dwelling in the country; the president likewise of mountains. He was moreover next to Mercury the messenger of the Gods. He was regarded as the leader and commander of the Nymphs, who were always wont to dance and frisk around him. The Satyrs and their elders the Sileni were also of his company. He had besides the power to inspire sudden terrors, such especially as were vain and superstitious, which received the name of *Panics*. Not many actions are recorded of him. The chief one is that he challenged Cupid at wrestling and was overcome in the contest. He also caught the giant Typhon in nets and held him fast. They say likewise that when Ceres, in sorrow and passion for the rape of Proserpine, had hid herself, and all the gods were eagerly engaged in seeking her, and had dispersed themselves in different paths for the pursuit, it was reserved for Pan to meet with her by a happy accident as he was hunting, and inform the rest of her hiding-place. He presumed also to contend in music with Apollo, and in the judgment of Midas was pronounced victor; for which judgment Midas had to wear the ears of an ass, but not so as to be seen. No amours, or at least very few, are related of Pan; a strange thing for one of a crowd of gods so profusely amorous. It is only said of him that he was the lover of Echo, who was also esteemed his wife; and of one other nymph besides, named Syringa; with desire for whom he was inflamed by the revengeful anger of Cupid, whom he had not scrupled to challenge to the wrestling. He is also said on one occasion to have drawn the Moon apart into deep woods. More-

over he had no issue (which likewise is a marvel, when the gods, especially those of the male kind, were so prolific), unless it were one daughter, a little handmaid named Iambe, who used to amuse strangers with ridiculous stories; and was supposed by some to be Pan's daughter by his wife Echo. The parable may be thus explained.

Pan (as the name itself imports) represents and denotes the Universe, or the All of Things. Concerning his origin there are only two opinions, nor can there indeed be more. For he either sprang from Mercury, that is, the Word of God (which the Holy Scripture places beyond question, and which was perceived also by those of the philosophers themselves who have been accounted most divine), or else from the seeds of things mixed and confused together. For some philosophers have set down the seeds of things as infinite in their substance; whence arose the doctrine of *Homœomeræ*, which Anaxagoras either invented or brought into repute. Some with greater penetration and judgment thought that the variety of things would be sufficiently explained, if the seeds were supposed to be in substance the same, but to take various, though certain and definite, figures; accounting for the rest by the position and connexion of the seeds one with the other; from which opinion emanated the doctrine of Atoms invented by Leucippus, and sedulously followed out by Democritus. Others, though they asserted one principle of things (as Thales, Water, Anaximenes, Air, Heraclitus, Fire), yet maintained that principle itself to be actually one, but potentially various and dispensable, as that which had latent within it the seeds of all things. But those who (like Plato and Aristotle)

have represented Matter as entirely despoiled, shapeless, and indifferent to forms, have approached much nearer to the figure of the parable. For they have made Matter as a common harlot, and Forms as suitors; so that all the opinions about the origins of things return to this point, and may be reduced to this distribution, — that the universe proceeds either from Mercury, or from Penelope and all her suitors. From the third story of Pan's origin, it would seem as if the Greeks, either by intercourse with the Egyptians or otherwise, had heard something of the Hebrew mysteries. For it relates to the state of the world, not at its very birth, but after the fall of Adam; exposed and made subject to death and corruption. For that state was and is the offspring of God and Sin (or Contumely). For the sin of Adam, when he wished to "become like God," was a kind of contumely. Therefore the threefold account of the birth of Pan may be allowed as true, if rightly distinguished with respect to facts and times. For this Pan (as we now view and understand him) is the offspring of the *Divine Word*, through the medium of *confused matter* (which itself however was the work of God), and with the help of *Sin*, and by Sin Corruption, entering in.

To the Nature of things, the *Fates* or Destinies of things are truly represented as sisters. For the beginnings, durations, and ends of things, as also their fallings, risings, labours, felicities, and in a word whatever may happen to an individual, are termed Fates; which, however, except it be in some noble individual (as a man, or a city, or a people), are commonly not observed and recognised. Now it is *Pan*, that is, the nature of things, that reduces these separate individuals

to such various conditions; insomuch that the chain of nature and the thread of the Fates are (so far as individuals are concerned) the same thing. In addition to this the ancients feigned that Pan lived always in the open air, but the Fates in a huge subterranean cave, whence they suddenly flew to men with exceeding swiftness; because nature and the face of the universe is open and visible, whereas the fates of individuals are secret and rapid. But if Fate be taken in a wider acceptation, so as to signify every event of any kind, and not the more noble only, yet in this sense too it excellently answers to the universal frame of things; seeing that there is nothing in the order of nature so small as to be without a cause, nor again anything so great but it depends on something else; so that the fabric of nature contains in her own lap and bosom every event whatever, both small and great, and developes them in due season by a fixed law. Therefore no wonder that the Parcæ are represented as sisters of Pan, and certainly legitimate. For Fortune is the child of the vulgar, and has only found favour with the lighter kind of philosophers. Indeed Epicurus seems not only to be profane, but also foolish, when he says, "That it is better to believe in the fable of the gods, than to assert the power of fate;"[1] as if anything in the universe could be like an island, separated from connexion with the rest. But Epicurus, accommodating and subjecting his natural to his moral philosophy (as appears from his own words), would not willingly admit any opinion that depressed or hurt the mind, and troubled or disturbed that *Euthumia* of his, which he had adopted from Democritus. And so being more

[1] Cf. Diog. Laert. x. 134.

fond of enjoying the sweets of thought than patient of the truth, he fairly threw off the yoke, and rejected both the necessity of Fate and the fear of the gods. And so much for the relationship of Pan to the Fates.

Horns are attributed to the Universe, broad at the base and pointed at the top. For all nature rises to a point like a pyramid. Individuals, which lie at the base of nature, are infinite in number; these are collected into Species, which are themselves manifold; the Species rise again into Genera; which also by continual gradations are contracted into more universal generalities, so that at last nature seems to end as it were in unity; as is signified by the pyramidal form of the horns of Pan. Nor need we wonder if the horns of Pan reach even to the heaven, seeing that the transcendentals of nature, or universal ideas, do in a manner reach up to divinity. And hence the famous chain of Homer (that is, the chain of natural causes) was said to be fastened to the foot of Jupiter's throne; and we see that no one has handled metaphysics and the eternal and immovable in nature, and withdrawn his mind for awhile from the variable succession of things, without falling at once on Natural Theology; so easy and near a passage is it from the top of the pyramid to matters divine.

The body of nature is elegantly and truly represented as covered with hair; in allusion to the rays of things. For rays are as the hairs or bristles of nature, nor is there anything which is not more or less radiant. This is seen most evidently in the faculty of sight, and no less in all magnetic virtue, and every effect which takes place at a distance. For whatever produces an effect at a distance may be truly said to emit rays. But

Pan's hair is especially long in the beard; because the rays of celestial bodies, especially of the sun, operate and pierce from a greater distance than any other; so that not only the surface, but even the interior of the Earth for some distance, is changed, wrought, and filled with spirit by them. And that figure of Pan's beard is the more elegant, because the sun himself, when the upper part is obscured by a cloud and his rays break out below, appears to the eye as bearded.

The body of nature is likewise most aptly described as biform, on account of the difference between bodies of the upper and lower world; whereof the former, from their beauty and regularity and constancy of motion, as well as their influence over the Earth and earthly things, are properly represented by the human figure, human nature participating of order and dominion. But the latter, by reason of their perturbation and irregular movements, and because they are for the most part ruled by the heavenly bodies, may be content with the figure of a brute beast. Moreover this same description of a biform body has reference to the participation of species; for there is no natural species which can be regarded as simple; every one seeming to participate and be made up of two. Thus man has somewhat of the brute, the brute somewhat of the plant, the plant somewhat of the body inanimate; so that all things are indeed biform, being compounded of a superior and inferior species. And it is a very acute allegory, that of the goat's feet; which refers to the upward motion of earthly bodies towards the regions of the air and heaven; where also they remain hanging, and whence they are rather forced down than descend of themselves. For the goat is a climbing animal, and

loves to hang from rocks and cling to the sides of precipices; a tendency which is also exhibited in a wonderful manner by substances which belong properly to the lower world; as appears most plainly in clouds and meteors. Nay a question was raised not without reason by Gilbert, who has written upon the magnet most laboriously and after the experimental method, whether heavy bodies may not, when removed to a great distance from the earth, gradually lose their downward tendency?

Of the two insignia which Pan bears in his hands, the one represents harmony, the other empire. For the pipe of seven reeds plainly denotes the consent and harmony of things, or concord mixed with discord (which is caused by the motion of the seven planets). For there are not found any other wanderings or manifest expatiations in the heavens, besides those of the planets, such as when combined and tempered with the regularity of the fixed stars and their eternal and invariable distance one from the other, may keep up and set in motion at once the constancy of species and the continual change of individuals. And if there be any lesser planets which are not visible, or any greater change in the heaven (as in some superlunary comets), it seems they are as pipes either entirely mute or vocal only for a season; inasmuch as their influences either do not approach so low as ourselves, or do not long interrupt the harmony of the seven pipes of Pan. That sheephook also representing empire contains a noble metaphor, alluding to the mixture of straight and crooked in the ways of nature. And this rod or staff is crooked principally in the upper part; because all the works of Divine Providence in the world are

mostly brought about in a mysterious and circuitous manner, so that while one thing appears to be doing another is doing really; as the selling of Joseph into Egypt, and the like. Moreover in all wise human governments, those who sit at the helm can introduce and insinuate what they desire for the good of the people more successfully by pretexts and indirect ways than directly. Nay (which perchance may seem strange), even in mere natural things you may deceive nature sooner than force her; so ineffectual and self-impeding are all things which are done directly; whereas on the other hand the indirect and insinuating way proceeds smoothly and gains its end. The cloak or mantle of Pan is ingeniously feigned to be the skin of a leopard; because it is full of spots. For the heavens are spotted with stars, the seas with islands, the earth with flowers; and even particular objects are commonly variegated on the surface, which may be regarded as their mantle.

The office of Pan could in no other way be so lively set forth and expressed, as by terming him the god of hunters. For every natural action, and indeed every motion and progression, is but a hunting. Arts and sciences hunt after their works; human counsels hunt after their ends; and all natural things hunt either after their food to preserve them, or after their pleasures and delights to perfect them (for all hunting is for the sake either of prey or pleasure); and this too by methods expert and sagacious:

> Torva leæna lupum sequitur, lupus ipse capellam:
> Florentem cytisum sequitur lasciva capella.[1]

[1] Virg. Eclog., ii. 63.: — The savage lioness the wolf pursues,
The wolf the kid, the kid the cytisus.

Pan is also the god of all dwellers in the country, because such men live more according to nature than in cities and courts, where nature is corrupted by too much cultivation; so that what the poet says of his mistress is by reason of such arts of luxury true likewise of nature,

Pars minima est ipsa puella sui.[1]

Pan is likewise termed the president of the mountains, because in mountains and high places nature is more open and exposed to sight and study. That Pan next to Mercury is the messenger of the gods is plainly a divine allegory; for next to the word of God, the image of the world is the herald of divine power and wisdom. "The heavens (says the Psalmist) declare the glory of God, and the firmament showeth his handiwork."[2]

Pan delights in the nymphs, that is in spirits; for the spirits of living creatures are the delight of the world. And with reason is he styled their leader, for each of them follows its own nature as a guide, round which after their own fashion they leap and frisk in endless variety and constant motion. And therefore one of the moderns has ingeniously referred all the powers of the soul to motion, and remarked on the conceit and precipitancy of some of the ancients, who in too eagerly fixing their eyes and thoughts on the memory, imagination, and reason, have neglected the Thinking Faculty, which holds the first place. For he who remembers or recollects, thinks; he who imagines, thinks; he who reasons, thinks; and in a word

[1] Ov. Rem. Amor. 344.: — So overlaid with ornament and art,
Herself is of herself the smallest part.

[2] Psalm xix. 1.

the spirit of man, whether prompted by sense or left to itself, whether in the functions of the intellect, or of the will and affections, dances to the tune of the thoughts; and this is the frisking of the Nymphs. And in their company are ever found the Satyrs and Sileni, that is old age and youth. For all things have their merry and dancing time, and again their heavy and tippling time; and to one who truly considers them the pursuits of either age may appear perhaps ridiculous and deformed, like a Satyr or Silenus. As for the Panic terrors, a most wise doctrine is therein propounded. For nature has implanted in every living creature apprehension and fear, as the means of preserving its own life and essence, and avoiding and repelling the attacks of things hurtful. And yet this same nature knows not how to keep a mean, but is always intermixing vain and useless fears with such as are salutary; so that all things (if they might be seen within) are full of panic terrors; especially things human; and most of all among the common people, who are exceedingly troubled and agitated by superstition (which is nothing else but a panic terror), especially in hard and anxious and adverse times. Nor is this superstition confined to the vulgar, but it passes occasionally from them to the wiser sort; as Epicurus has said divinely (if only his other doctrines concerning the gods had breathed the same spirit), "It is not profane to deny the gods of the vulgar, but to apply the ideas of the vulgar to the gods."[1]

With regard to the presumption of Pan, and his challenging Cupid to wrestle, the meaning is that Matter is not devoid of an appetite and inclination to dis-

[1] Diog. Laert. x. 123.

solve the world and fall back into the old Chaos, but that its force and malice is restrained and kept in order by the prevailing concord of things (which is signified by Love or Cupid). And therefore it falls out most luckily (or say rather by the infinite goodness of God) for man and the world, that Pan has the worst of that contest and goes away defeated. The same thing is alluded to in that other circumstance of catching Typhon in a net; because however it be that vast and strange swellings (for that is the meaning of Typhon) take place occasionally in nature,—whether of the sea or the clouds or the earth or any other body,—nevertheless all such exuberances and irregularities are by the nature of things caught and confined in an inextricable net, and bound down as with a chain of adamant.

As for the tale that the discovery of Ceres was reserved for this god, and that while he was hunting, and denied to the rest of the gods, though diligently and specially engaged in seeking her, it contains a very true and wise admonition; which is, not to look for the invention of things useful for life and civilisation from abstract philosophies, which are as it were the greater gods, even though they devote all their strength to the purpose; but only from Pan, that is from sagacious experience and the universal knowledge of nature; which oftentimes, by a kind of chance, and while engaged as it were in hunting, stumbles upon such discoveries. For the most useful inventions are due to experience, and have come to men like windfalls.

Again that contest in music and the issue of it exhibits a wholesome doctrine, and one which may well restrain and reduce to sobriety the pride and

overweening confidence of human reason and judgment. For it seems that there are two kinds of harmony and music; one of divine wisdom, the other of human reason. And to the human judgment, and the ears as it were of mortals, the government of the world and the more secret judgments of God sound somewhat harsh and untunable; and though this be ignorance, such as deserves to be distinguished with the ears of an ass, yet those ears are worn secretly and not in the face of the world; for it is not a thing observed or noticed as a deformity by the vulgar.

Lastly it is no marvel if no loves are attributed to Pan, besides his marriage with Echo. For the world enjoys itself, and in itself all things that are. Now he who is in love wants something; and where there is plenty of everything there is no room for want. The world therefore can have no loves, nor any want (being content with itself), unless it be of *discourse*. Such is the nymph Echo, a thing not substantial but only a voice; or if it be of the more exact and delicate kind, *Syringa*,—when the words and voices are regulated and modulated by numbers, whether poetical or oratorical. But it is well devised that of all words and voices Echo alone should be chosen for the world's wife; for that is the true philosophy which echoes most faithfully the voices of the world itself, and is written as it were at the world's own dictation; being nothing else than the image and reflexion thereof, to which it adds nothing of its own, but only iterates and gives it back.

The story that Pan once drew the Moon apart into deep woods, seems to have reference to the intercourse of sense with heavenly or divine things. For the case of Endymion is different from that of Pan. To En-

dymion the Moon descended of her own accord as he slept; for divine influences sometimes steal spontaneously into the understanding when at rest, and withdrawn from the senses; but if they are invoked and solicited by the sense, as by Pan, then they afford no other light but that,

> Quale per incertam Lunam sub luce maligna
> Est iter in silvis.[1]

That the world has no issue is another allusion to the sufficiency and perfection of it in itself. Generation goes on among the parts of the world; but how can the whole generate, when no body exists out of itself? As for that little woman, Iambe, Pan's putative daughter, it is an addition to the fable with a great deal of wisdom in it; for by her are represented those vain babbling doctrines about the nature of things, which wander abroad in all times and fill the world; doctrines barren in fact, counterfeit in breed, but by reason of their garrulity sometimes entertaining, and sometimes again troublesome and annoying.

Another Example of Philosophy according to the Ancient Parables, in Politics. *Of War, according to the story of* Perseus.

Perseus, an Eastern man, was sent, it is said, by Pallas to destroy Medusa, who was a grievous plague to many nations of the West in the furthest parts of Spain. She was a monster, otherwise huge and savage, and of an aspect so foul and hideous that her look alone turned men into stones. Now Medusa was one of the Gorgons, and the only mortal amongst them, the others

[1] Virg. Æn. vi. 270.: — As by the wayward moon's inconstant light
A path through woods . . . .

not being subject to death. Perseus then, equipping himself for so noble an enterprise, borrowed arms as presents from three of the gods; from Mercury wings, — fitted to the ankles, not the shoulders; from Pluto a helmet; from Pallas a shield and mirror. Nevertheless (though he was now so well furnished) he did not go direct to Medusa, but turned aside to the Grææ. These were the half-sisters of the Gorgons; and were grey-headed from their birth, and like old women. They had but one eye and one tooth among them all; which, as they had occasion to go abroad, each wore by turns and put off again when she came back. This eye and this tooth they lent to Perseus. And now judging himself sufficiently armed to effect his purpose, he went against Medusa with all haste, flying. Her he found sleeping; but not daring to meet her gaze (in case she should wake), he turned his face away, and looking into the mirror of Pallas to direct his blow, cut off her head. From her blood spilt upon the ground immediately sprang forth Pegasus the winged horse. But the severed head Perseus transferred to the shield of Pallas, and fixed it there; where it still retained its former virtue, that whoever gazed upon it became as it were thunder or planet struck.

This fable seems to have been devised with reference to method and prudence in making war. And first, the undertaking of every war ought to be as a mission from Pallas; not from Venus (as the Trojan war was), or for any other slight motive; for resolutions respecting wars ought to be based on solid counsels. Secondly, with regard to the kind of war to be chosen, the fable propounds three very wholesome and important precepts. The first is, not to make too great a point of

subjugating the neighbouring nations. For the method of enlarging a patrimony and an empire is not the same. In private estates contiguity of lands is taken into account, but in the extension of empire, occasion and facility for making war and fruit of conquest ought to be regarded in place of contiguity. And therefore Perseus, though in the East, did not shrink from an expedition even to the far West. Of this there is a notable instance in the different modes of war practised by Philip and Alexander, father and son. The former, engaging in wars with neighbouring countries, after much exertion and danger (for both at other times and especially at Chæronea he was reduced to extreme peril), added a few cities to his empire; whereas Alexander, with wise boldness undertaking a distant expedition into Persia, subjugated an infinite number of nations, and suffered more by his marches than his battles. But perhaps this difference is shown still more clearly in the increase of the empire of the Romans, who while they had scarce penetrated westward beyond Liguria, had already conquered and included within their empire eastern provinces as far off as Mount Taurus. So Charles the Eighth, King of France, having found the war with Bretagne (afterwards arranged by marriage) no easy matter, undertook that distant enterprise against Naples, which he effected with wonderful ease and success. Certainly wars made upon distant nations have this advantage, that the invaders have to fight with those who have no experience of their mode of warfare and arms; whereas in a war with neighbours it is otherwise. Moreover the equipment of such expeditions is generally more perfect and better appointed, and the very boldness and confidence of the

aggressor inspires greater terror into the enemy. Nor does it often happen in these distant expeditions that the enemy to whom the war is brought from such a distance can make diversions or counter-invasions, as is the case in wars between neighbours. But the chief point is, that in subduing neighbouring states there is only a small choice of opportunities; whereas in distant enterprises the aggressor may carry the war at pleasure, either where military discipline is most relaxed, or the strength of a people is most weakened and impaired, or the rise of civil dissension and other like opportunities present themselves. The second precept is, that there must ever be a cause of war, just, pious, honourable, and popular. For this begets alacrity as well in the soldiers, as in those who provide the funds, opens the way to alliances, and conciliates friends, and has many other advantages. Now among the causes of war few are more popular than the putting down of tyrannies, beneath whose yoke the spirit and energy of the people are worn down and prostrated, as by the head of Medusa; a thing which gained Hercules divine honours. Certainly the Romans made it a great point of duty to hasten with all speed to succour their allies when in any way attacked. Wars also undertaken for a just revenge have almost always been successful; as the war against Brutus and Cassius to avenge the murder of Cæsar; of Severus to avenge the death of Pertinax; of Junius Brutus to avenge the death of Lucretia. In a word, whosoever either relieves or avenges by war the calamities and injuries of men, bears arms under Perseus. The third precept is, that in every war a true estimate of strength must be taken, and it must be duly considered whether the war

be such as can be carried through and brought to an issue; so that one may not engage in pursuit of vast and boundless projects. For of the Gorgons (which are the representatives of war) Perseus wisely chose her alone who was of mortal nature, nor did he attempt impossibilities. Such then is the advice which the fable gives touching the things that require deliberation in undertaking war; the rest relate to the carrying it on.

In war those three gifts of the gods are of all things the most important; insomuch that they commonly command and carry with them fortune itself. For Perseus received speed from Mercury, secrecy of counsels from Orcus, and foresight from Pallas. And it is not without allegory, and that of the wisest sort, that those wings of speed (seeing speed is of much avail in war) were attached to the feet and not to the shoulders; because celerity is required not so much in the first onsets of war as in the pursuit and following up thereof. For no error in war is more common than this, that the prosecutions and subsidiary actions correspond not to the energy of the first commencements. And the helmet of Pluto (which used to render men invisible) is a manifest parable. For next to speed in war secrecy of counsels is of the greatest moment; of which indeed speed itself is a great part; for speed anticipates the disclosures of counsels. To the helmet of Pluto belongs also this: that there should be one commander in a war, with free instructions; for consultations held with many savour more of the crests of Mars than the helmet of Pluto. Variety of pretexts, ambiguous directions, rumours spread abroad, which either blind or avert men's eyes and involve the real designs in obscurity, refer to the same. So also diligent and suspicious

precautions respecting despatches, ambassadors, deserters, and many like matters, are wreathed round the helmet of Pluto. But it is of no less importance to discover the counsels of the enemy than to conceal our own. To the helmet of Pluto therefore must be added the mirror of Pallas, whereby to discern the strength or weakness of the enemy, their secret partisans, their discords and factions, their movements and designs. But since there is so much of chance in war, that no great confidence can be placed either in discovering the designs of the enemy, or in concealing our own, or even in speed itself, we must take special care to be armed with the shield of Pallas, that is, of foresight, so as to leave as little as possible to fortune. To this belong the exploring of roads before a march, the careful fortification of the camp (which in modern warfare has fallen almost into disuse, whereas the camps of the Romans were like a fortified town, to fall back upon in case of defeat), a firm and well drawn up line of battle, not trusting too much to light troops, or even to cavalry; in a word, everything which relates to a sound and careful system of defensive war; for the shield of Pallas is generally of more avail in war, than the sword of Mars itself. But Perseus, however furnished with forces and courage, has still need of one thing more, of the greatest possible importance, before he commences the campaign; he must turn aside to the Grææ. Now the Grææ are Treasons, which are the Sisters of War, though not indeed own sisters, but as it were of less noble birth. For wars are noble and generous; treasons degenerate and base. They are portrayed appropriately as being grey-headed from their birth and like old women, by reason of the perpetual cares and anxie-

ties attending traitors. Their power (before they openly desert) is in the eye or tooth; for all faction, when discontented and inclined to treason, is both watchful and biting. Moreover this eye and tooth are, as it were, common to them all; for whatever they learn and discover is handed from one to another, and circulates through the whole party. And with regard to the tooth, they all bite as it were with one mouth, and utter the same scandals; so that if you hear one, you hear all. Wherefore Perseus must conciliate these Grææ, and bring them into alliance with him, especially that they may lend him their eye and tooth; the eye to gain information; the tooth to spread rumours, raise envy, and gain over the minds of men. But when everything has been arranged in order for war, we must take special care, like Perseus, to find Medusa asleep; for he who undertakes a war wisely will almost always attack his enemy unprepared and in security. Lastly, in the very actions and onsets of war the mirror of Pallas must be resorted to; for there are many who before the time of danger can take a clear and accurate survey of the position of the enemy, but in the very moment of peril they are either stupified with terror, or look their dangers too rashly in the face; and so rush madly into them, bent on overcoming, not on avoiding them. Neither of which things should be done; but we should turn aside the head and look into the mirror of Pallas, that the onset may be rightly directed without either terror or fury.

From the conclusion of the war and victory follow two effects, first, the birth and springing up of Pegasus, which evidently enough signifies Fame that flies abroad and proclaims the victory, and so makes what remains

of the war easy and satisfactory; secondly, the carrying of Medusa's head on the shield; to which for excellence no other kind of defence can be compared. For one great and memorable enterprise successfully carried out paralyses every movement of the enemy, and stupifies disaffection itself.

The third Example of Philosophy according to the Ancient Fables, in Moral Philosophy. *Of Desire, according to the fable of* Dionysus.

THEY say that Semele, the mistress of Jupiter, having bound him by an inviolable oath to grant her a request whatever it might be, desired of him to come to her arms in the same form as he would to Juno; and so she was scorched to death in his embrace. The child which she bore in her womb was taken by his father and sewn up in his thigh, till the time of gestation was accomplished. And because the child, when in the thigh of Jupiter, pinched and galled him so as to make him limp, he received the name of Dionysus. After he was brought forth he was nursed for some years by Proserpine; and when he grew up his face was so like a woman's that it seemed doubtful of which sex he was. He was likewise once dead and buried for a time, but came to life again not long after. In his early youth he was the first to invent and explain the culture of the vine, and the making of wine, and its use; whereby becoming renowned and illustrious, he subdued the whole world and advanced to the furthest parts of India. He rode in a chariot drawn by tigers, round which danced certain deformed demons called Cobali; Acratus and others. The Muses also attended

in his train. He took to wife Ariadne, whom Theseus had deserted and abandoned. His sacred tree was the ivy. He was regarded likewise as the inventor and institutor of sacred rites and orgies; but such as were fanatical and full of corruption, and moreover cruel. He had also the power of exciting phrensy. At least it was by women excited to phrensy in his orgies that two renowned men, Pentheus and Orpheus, are said to have been torn to pieces; the one having climbed into a tree out of curiosity to see what they were doing; the other while playing sweetly and skilfully on the lyre. Moreover the actions of this god are often confounded with those of Jupiter.

The fable appears to relate to morals; and indeed there is scarcely anything better to be found in moral philosophy. Under the person of Bacchus is depicted the nature of Desire, or the passions and perturbations of the mind. First therefore, with regard to the origin of Desire. The mother of all desire (though ever so hurtful) is nothing else than apparent good. For as the mother of virtue is real good, so the mother of desire is apparent good. One the lawful wife of Jupiter (in whose person the human soul is represented), the other his mistress; who nevertheless aspires, like Semele, to the honours of Juno. Now the conception of Desire is always in some unlawful wish, rashly granted before it has been understood and weighed; and as the passion warms, its mother (which is the nature and species of good), not able to endure the heat of it, is destroyed and perishes in the flame. Then the progress of Desire from its first conception is of this kind. It is both nursed and concealed in the human mind (which is its father); especially in the lower

part of it, as in the thigh; where it causes such prickings, pains, and depressions, that the actions and resolutions of the mind labour and limp with it. And even when it has grown strong with indulgence and custom, and breaks forth into acts (as if it had now accomplished its time and were fairly born and delivered), yet at first it is brought up for a time by Proserpine; that is, it seeks hiding-places and keeps itself secret, and as it were underground; until throwing off all restraints of shame and fear, and growing bolder and bolder, it either assumes the mask of some virtue, or sets infamy itself at defiance. And it is most true that every passion of the more violent kind is as it were of doubtful sex; for it has at once the force of a man and the weakness of a woman. It is well said likewise that Bacchus died and came to life again; for the passions seem sometimes lulled to sleep, and as it were dead; yet can they never be trusted, no not though they be buried. For give them matter and opportunity and they will rise again.

It is a wise allegory too, that of the invention of the vine. For every passion is very ingenious and sagacious in discovering the things which nourish and foster itself. Now of all things known to man wine is the most powerful and efficacious in stimulating and inflaming every kind of excitement; serving as a common fuel to desires in general. Very elegantly too is passion or desire described as the subduer of provinces and the undertaker of an endless course of conquests. For it is never content with what it has got, but with infinite and insatiable appetite tries for something more, and ever craves for new triumphs. Tigers likewise are kept in the stables of the passions, and at times yoked

to their chariot; for when passion ceases to go on foot and comes to ride in its chariot, as in celebration of its victory and triumph over reason, then is it cruel, savage, and pitiless towards all that withstand or oppose it. Again there is humour in making those ridiculous demons dance about the chariot of Bacchus. For every passion of the more vehement kind produces motions in the eyes, and indeed in the whole countenance and gesture, which are uncomely, unsettled, skipping, and deformed; insomuch that when a man under the influence of any passion (as anger, scorn, love, or the like) seems most grand and imposing in his own eyes, to the lookers on he appears unseemly and ridiculous. It is true also that the Muses are seen in the train of passion; there being scarce any passion which has not some branch of learning to flatter it. For herein the majesty of the Muses suffers immensely from the license and wantonness of men's wits, turning those that should be the guides and standard-bearers of man's life into mere followers in the train and ministers to the pleasures of the passions.

Especially noble again is that part of the allegory which represents Bacchus as lavishing his love upon one whom another man had cast off. For most certain it is that passion ever seeks and aspires after that which experience has long since repudiated. And let all men who in pursuit and indulgence of their passions care not what price they pay for the enjoyment of them, know this: that whatever be the object of their pursuit — be it honour or fortune or love or glory or knowledge, or what it may — they are paying court to things cast off, — things which many men in all times have tried, and upon trial rejected with disgust.

Nor is the consecration of Ivy to Bacchus without its mystery. For this has a double propriety. First, because ivy flourishes in the winter; next because it has the property of creeping and spreading about so many things, as trees, walls, buildings, &c. For as to the first, every passion flourishes and acquires vigour by being resisted and forbidden, as by reaction or *antiperistasis;* like the ivy by the cold of winter. As to the second, any predominant passion in the human spirit spreads itself like ivy round all its actions and resolves, so that you cannot find anything free from the embrace of its tendrils. Neither is it to be wondered at if superstitious rites are attributed to Bacchus; for almost every insane passion grows rank in depraved religions, insomuch that the pollutions of heretics are worse than the Bacchanalian orgies of the heathen; whose superstitions likewise have been no less bloody than foul. Neither again is it wonderful that phrensies are thought to be inspired by Bacchus; since every passion, in the excess thereof, is like a short madness, and if it continue vehement and obstinate, commonly ends in insanity. And that circumstance of the tearing to pieces of Pentheus and Orphéus amid the orgies of Bacchus, has an evident allegorical meaning; for every ruling passion is extremely hostile and inveterate against two things; whereof the one is curious inquisition; the other, free and wholesome advice. Nor does it make any difference if that inquisition be merely for the sake of looking on, as from a tree, without any ill-feeling; nor again if the advice be tendered ever so sweetly and skilfully; for the orgies cannot upon any conditions endure either Pentheus or Orpheus. Lastly, the confusion of the persons of Jupiter and Bacchus

may well be taken in an allegorical sense. For noble and illustrious actions and glorious and distinguished services proceed sometimes from virtue, right reason, and magnanimity; and sometimes (however they are extolled and applauded without distinction) only from lurking passion and hidden desire; and thus the deeds of Bacchus are not easily distinguished from the deeds of Jupiter.

But we stay too long in the theatre; let us now pass to the palace of the mind, which we are to approach and enter with more reverence and attention.

OF

THE ADVANCEMENT OF LEARNING.

BOOK III.

CHAPTER I.

Division of Science into Theology *and* Philosophy. *Division of Philosophy into three doctrines; concerning the* Deity, *concerning* Nature, *and concerning* Man. *Constitution of* Primary Philosophy, *as the common mother of all.*

ALL History, excellent King, walks upon the earth, and performs the office rather of a guide than of a light; whereas Poesy is as a dream of learning; a thing sweet and varied, and that would be thought to have in it something divine; a character which dreams likewise affect. But now it is time for me to awake, and rising above the earth, to wing my way through the clear air of Philosophy and the Sciences.

The knowledge of man is as the waters. Some waters descend from above, and some spring from beneath; and in like manner the primary division of sciences is to be drawn from their sources; of which some are above in the heavens, and some here below. For all knowledge admits of two kinds of information; the one inspired by divine revelation, the other arising

from the senses. For as to that knowledge which man receives by teaching, it is cumulative and not original; as it is likewise in waters, which beside their own springheads, are fed with other springs and streams. I will therefore divide knowledge into Divinity and Philosophy; meaning by Divinity Sacred or Inspired, not Natural Divinity; of which I will speak hereafter. But this (namely, Inspired Divinity) I will reserve to the end, that with it I may conclude my discourse; being as it is the haven and sabbath of all human contemplations.

The object of philosophy is threefold—God, Nature, and Man; as there are likewise three kinds of ray—direct, refracted, and reflected. For nature strikes the understanding with a ray direct; God, by reason of the unequal medium (viz. his creatures), with a ray refracted; man, as shown and exhibited to himself, with a ray reflected. Philosophy may therefore be conveniently divided into three branches of knowledge: knowledge of God, knowledge of Nature, and knowledge of Man, or Humanity. But since the divisions of knowledge are not like several lines that meet in one angle; but are rather like branches of a tree that meet in one stem (which stem grows for some distance entire and continuous, before it divide itself into arms and boughs); therefore it is necessary before we enter into the branches of the former division, to erect and constitute one universal science, to be as the mother of the rest, and to be regarded in the progress of knowledge as portion of the main and common way, before we come where the ways part and divide themselves. This science I distinguish by the name of *Philosophia Prima*, primitive or summary philosophy; or *Sapience*,

which was formerly defined as the knowledge of things divine and human. To this no other is opposed; for it differs from the rest rather in the limits within which it ranges than in the subject matter; treating only of the highest stages of things. Which science whether I should report as deficient or not, I stand doubtful, though I rather incline to do so. For I find a certain rhapsody and incongruous mass of Natural Theology, of Logic, and of some parts of Natural Philosophy (as those concerning First Principles and the Soul), all mixed up and confused, and in the lofty language of men who take delight in admiring themselves advanced as it were to the pinnacle of the sciences. But setting all high conceits aside, my meaning is simply this: that a science be constituted, which may be a receptacle for all such axioms as are not peculiar to any of the particular sciences, but belong to several of them in common.

Now that there are very many axioms of that kind need not be doubted. For example, "if equals be added to unequals the wholes will be unequal," is a rule of mathematics. The same holds in ethics, as regards distributive justice; for in commutative justice the rule of equity requires that equals be given to unequals; whereas in distributive, if unequals be not given to unequals there is the greatest injustice.[1] Again "things that are equal to the same are equal to one another," is likewise a rule of mathematics; but it is at the same time so potent in logic as to be the basis of the syllogism. "The nature of everything is best seen in its smallest portions," is a rule in Physics of such force that it produced the atoms of Democ-

[1] Cf. Arist. Nic. Eth. v. 3, 4, 5.

ritus; and yet Aristotle made good use of it in his Politics, where he commences his inquiry of the nature of a commonwealth with a family. "All things are changed and nothing is lost,"[1] is in like manner a rule in Physics, exhibited thus, "The Quantum of nature is neither diminished nor increased." The same holds in Natural Theology, with this variation, "It is the work of omnipotence to make somewhat nothing, and to make nothing somewhat;" which likewise the Scripture testifies; "I know that whatsoever God doeth, it shall be for ever; nothing can be put to it, nor anything taken from it."[2] "Things are preserved from destruction by bringing them back to their first principles," is a rule in Physics; the same holds good in Politics (as Macchiavelli rightly observed), for there is scarcely anything which preserves states from destruction more than the reformation and reduction of them to their ancient manners.[3] "Putrefaction is more contagious before than after maturity," is a rule in Physics; the same is eminently true in Morals, for the men who are most wicked and profligate produce less corruption in the public manners than those who appear to have some soundness and virtue in them, and are only partly evil. "Whatever is preservative of a greater Form is more powerful in action," is a rule in Physics; for that the connexion of things should not be severed, nor a vacuum (as they call it) admitted, tends to preserve the fabric of the universe; whereas the collection of heavy bodies towards the mass of the earth tends to preserve only the region of dense bodies; and therefore the first motion overcomes the last. The

[1] Ovid. Metam. xv. 165. [2] Ecclesiastes iii. 14.
[3] Macch. Discorsi, § 1.

same holds in Politics; for whatsoever contributes to preserve the whole state in its own nature, has greater power than that which only benefits the particular members of that state. It holds likewise in Theology; for of the theological virtues, charity, which is the virtue most communicative of good, excels all the rest. "The force of an agent is increased by the reaction of a contrary," is a rule in Physics. The same has wonderful efficacy in Politics, since every faction is violently irritated by the encroachment of a contrary faction. "A discord ending immediately in a concord sets off the harmony," is a rule in Music. The same holds in Ethics and in the affections. The trope of Music, to glide gently from the close or cadence (as they call it) when you seem to be on the point of it, resembles the trope of Rhetoric, of deceiving expectation. The quavering upon a stop in music gives the same pleasure to the ear as the playing of light on water or a diamond gives to the eye;

—— splendet tremulo sub lumine pontus.[1]

"The organs of the senses resemble the organs of reflexions," is a rule in Perspective; for the eye is like to a glass, or to water; and it is the same in Acoustics, for the instrument of hearing is like an obstruction in a cavern. These few cases are enough by way of examples. But indeed the chief business of the Persian magic (so much celebrated) was to note the correspondences between the architectures and fabrics of things natural and things civil. Neither are all these which I have mentioned, and others of this kind, only similitudes (as men of narrow observation may per-

[1] Virg. Æn. vii. 9.: — Beneath the trembling light glitters the sea.

haps conceive them to be), but plainly the same footsteps of nature treading or printing upon different subjects and matters. And it is a thing which has not as yet been carefully handled. You may perhaps find in the writings of the profounder sort of wits such axioms here and there sparingly inserted for the use of the argument they have in hand; but for any body of such axioms, which should tend primitively and summarily to the advancement of the sciences, no one has as yet collected one, though it is a thing of excellent use for displaying the unity of nature; which is supposed to be the true office of Primitive Philosophy.

There is also another part of this philosophy, which, if you look to the terms, is ancient, if to the thing which I mean, is new. It is an inquiry with regard to the Adventitious Conditions of Essences (which we may call Transcendentals), as Much, Little; Like, Unlike; Possible, Impossible; likewise Being and Not-Being, and the like. For since these do not properly come under Physic, and the logical discussion concerning them belongs rather to the laws of reasoning than to the existence of things, it is very proper that the consideration of them (wherein there is no little dignity and profit) should not be altogether neglected, but should find at least some place in the divisions of the sciences. Nevertheless I mean that it should be handled in a way very different from the common. For example; no one who has treated of Much and Little has endeavoured to assign a reason why some things in nature are and can be so numerous and plentiful, others so few and scanty; for it certainly cannot be that in the nature of things there should be as much gold as iron; that roses should be as abundant as grass;

and that there should be as great variety of the specific as of the non-specific. In like manner no one in handling Similitude and Diversity has sufficiently explained why betwixt different species there almost always lie certain individuals which partake of the nature of both; as moss between corruption and a plant; fishes that stick to rocks and cannot move away, between a plant and an animal; rats and mice, and some other things, between animals generated of putrefaction and of seed; bats, between birds and beasts; flying-fish (which are now well known), between birds and fishes; seals, between fishes and quadrupeds; and the like. Nor has any one inquired the reason why, seeing that likes delight in likes, iron does not attract iron, which the magnet does; nor why gold does not attract gold, though it does attract quicksilver. With regard to these and similar things in the discussion of Transcendentals there is a deep silence; for men have aimed rather at height of speech than at the subtleties of things. Wherefore I wish the real and solid inquiry, according to the laws of nature and not of language, concerning these Transcendentals or Adventitious Conditions of Essences, to have a place in Primitive or Summary Philosophy. And so much for *Philosophia Prima* (or Sapience), which I have with reason set down as deficient.

CHAP. II.

Of Natural Theology; *and the Doctrine concerning* Angels *and* Spirits, *which is an Appendix of the same.*

THIS science being therefore first placed as a common parent, like unto Berecynthia, who had so much heavenly issue,

Omnes cœlicolas, omnes supera alta tenentes,[1]

let us return to the former division of the three philosophies: Divine, Natural, and Human. For Natural Theology is also rightly called Divine Philosophy. It is defined as that knowledge, or rather rudiment of knowledge, concerning God, which may be obtained by the light of nature and the contemplation of his creatures; and it may be truly termed divine in respect of the object, and natural in respect of the light. The bounds of this knowledge, truly drawn, are that it suffices to refute and convince Atheism, and to give information as to the law of nature; but not to establish religion. And therefore there was never miracle wrought by God to convert an atheist; because the light of nature might have led him to confess a God; but miracles have been wrought to convert idolators and the superstitious, who acknowledged a deity but erred in his worship; because no light of nature extends to declare the will and worship of God. For as all works show forth the power and skill of the workman, and not his image; so it is of the works of God, which show the omnipotency and wisdom, but do not portray the image of the Maker. And therefore

[1] Virg. Æn. vii. 788.: — All gods, all dwelling in the heights of heaven.

therein the Heathen opinion differs from the sacred truth; for they supposed the world to be the image of God, and man the image of the world; whereas the Scriptures never vouchsafe to attribute to the world such honour as anywhere to call it the image of God, but only the work of his hands; but man they directly term the image of God. Wherefore that God exists, that he governs the world, that he is supremely powerful, that he is wise and prescient, that he is good, that he is a rewarder, that he is an avenger, that he is an object of adoration—all this may be demonstrated from his works alone; and there are many other wonderful mysteries concerning his attributes, and much more touching his regulations and dispensations over the universe, which may likewise be reasonably elicited and manifested from the same; and this is an argument that has by some been excellently handled. But on the other side, out of the contemplation of nature and elements of human knowledge to induce any conclusion of reason or even any strong persuasion concerning the mysteries of faith, yea, or to inspect and sift them too curiously and search out the manner of the mystery, is in my opinion not safe. "Give unto faith the things which are faith's." For the Heathen themselves concede as much, in that excellent and divine fable of the Golden Chain; namely, that men and Gods were not able to draw Jupiter down to the earth; but contrariwise, Jupiter was able to draw them up to heaven. And therefore it were a vain labour to attempt to adapt the heavenly mysteries of religion to our reason. Fitter will it be that we raise our own minds to the adorable throne of heavenly truth. In this part therefore of Natural Theology I am so far

from noting any deficience, that I rather find an excess; to note which I have a little digressed, because of the extreme prejudice and peril which is thereby threatened both to religion and philosophy; as being that which will make at once an heretical religion and an imaginary and fabulous philosophy.

Otherwise it is of the nature of Angels and Spirits, which is neither inscrutable nor interdicted; unto which likewise, from the affinity it bears to the human soul, the passage is in great part opened. Certainly the Scripture says, "Let no man deceive you in sublime discourse, touching the worship of angels, pressing into that he knoweth not;"[1] yet notwithstanding if you observe well that precept, you will find that there are two things only forbidden therein: adoration of them, such as is only due to God, and opinion fantastical of them; either to extol them further than appertains to the degree of a creature, or to extol a man's knowledge of them further than he has ground. But the sober inquiry about them, either ascending to the knowledge of their nature by the ladder of things corporeal, or beholding it in the soul of man as in a mirror, is nowise forbidden. So of unclean and fallen spirits, the conversing with them or the employment of them is prohibited; much more any worship or veneration towards them. But the contemplation and knowledge of their nature, power and illusions, not only from passages of Scripture, but from reason or experience, is not the least part of spiritual wisdom. So certainly says the Apostle, "We are not ignorant of his stratagems."[2] And it is no more unlawful to inquire the nature of evil spirits in Natural Theology,

[1] Coloss. ii. 4. and 18. [2] 2 Corinth. ii. 11.

than to inquire the force of poisons in Physics, or the nature of vice in Ethics. But this part of knowledge touching angels and spirits I cannot note as deficient, seeing many have occupied themselves in it. I may rather challenge no small part of it, in many of the writers thereof, as superstitious, fabulous, and fantastical.

CHAP. III.

The division of Natural Philosophy into Speculative *and* Operative; *and that these two should be kept separate, both in the intention of the writer and in the body of the treatise.*

Leaving therefore Natural Theology (to which I refer the inquiry concerning Spirits as an appendix), let us now proceed to the second part; namely, that concerning Nature and Natural Philosophy. It was well said by Democritus, "That the truth of nature lies hid in certain deep mines and caves."[1] It was not ill said by the alchemists, "That Vulcan is a second nature, and imitates that dexterously and compendiously which nature works circuitously and in length of time." Why therefore should we not divide Natural Philosophy into two parts, the mine and the furnace; and make two professions or occupations of natural philosophers, some to be miners and some to be smiths? And certainly though I may seem to say this in sport, yet I think a division of this kind most useful, when propounded in familiar and scholastical terms; namely, that the doctrine of Natural Philosophy be

[1] Diog. Laert. in Pyrrho, c. 72.

divided into the Inquisition of Causes, and the Production of Effects; Speculative and Operative. The one searching into the bowels of nature, the other shaping nature as on an anvil. And though I am well aware how close is the intercourse between causes and effects, so that the explanations of them must in a certain way be united and conjoined; yet because all true and fruitful Natural Philosophy has a double scale or ladder, ascendent and descendent, ascending from experiments to axioms, and descending from axioms to the invention of new experiments; therefore I judge it most requisite that these two parts, the Speculative and the Operative, be considered separately, both in the intention of the writer and in the body of the treatise.

CHAP. IV.

The division of Speculative doctrine concerning nature into Physic (*special*) *and* Metaphysic. *Whereof Physic inquires of the* Efficient Cause *and the* Material; *Metaphysic of the* Final Cause *and the* Form. *The division of Physic* (*special*) *into the doctrine concerning the* Principles of Things, *concerning the* Fabric of Things, *or the world, and concerning the* Variety of Things. *The division of the doctrine concerning the Variety of Things into doctrine concerning things* Concrete, *and doctrine concerning things* Abstract. *The division of the doctrine concerning things Concrete is referred to the same divisions which Natural History receives. The division of the doctrine concerning things Abstract into doctrine concerning the* Configurations of Matter *and*

doctrine concerning Motions. *Two Appendices of Speculative Physic*, Natural Problems *and* Dogmas of the Ancient Philosophers. *The division of Metaphysic into doctrine concerning* Form *and the doctrine concerning* Final Causes.

THAT part of Natural Philosophy which is Speculative and Theoretical, we may divide into Physic special, and Metaphysic; wherein I desire men to observe that I use the word *metaphysic* in a different sense from that which is commonly received. And here it may be convenient to explain my general purpose touching the use of terms; which is, as well in this term of metaphysic, as in other cases where my conceptions and notions are novel and differ from the ancient, to retain with scrupulous care the ancient terms; for hoping well that the very order of the matter and the clear explanation which I give of everything will prevent the words I use from being misunderstood, I am otherwise zealous (as far as may stand with truth and the proficience of knowledge) to recede as little as possible from antiquity, either in terms or opinions. And herein I cannot a little marvel at the boldness of Aristotle, who was stirred by such a spirit of difference and contradiction to wage war on all antiquity, undertaking not only to coin new words of science at pleasure, but to extinguish and obliterate all ancient wisdom; insomuch that he never names or mentions an ancient author or opinion but to reprove the one and refute the other. For glory, indeed, and drawing followers and disciples he took the right course therein. For certainly in the promulgation and reception of philosophic truth the same thing comes to pass that was noted in the case of divine truth; "I came in my

Father's name, and ye received me not; if one shall come in his own name, him ye will receive."[1] But in this divine aphorism, if we consider to whom it was applied (namely, to Anti-Christ, the highest deceiver of all ages), we may discern this well, that the coming in a man's own name, without regard of antiquity or (so to say) of paternity, is no good sign of truth, though it be oftentimes joined with the fortune and success of "him ye will receive." But of Aristotle, so excellent a person as he was, and so wonderful for the acuteness of his mind, I can well believe that he learnt that humour from his scholar, whom perhaps he emulated; the one aspiring to conquer all nations, the other to conquer all opinions, and to establish for himself a kind of despotism in thought. Wherein nevertheless, it may be, he may at some men's hands who are of a bitter temper and a sharp tongue get a like title as his scholar did;

> Felix terrarum prædo, non utile mundo
> Editus exemplum:[2]
>
> Felix doctrinæ prædo, &c.

But to me on the other side (who desire, as much as lies in my pen, to ground a sociable intercourse between the old and the new in learning) it seems best to keep way with antiquity in all things lawful, and to retain the ancient terms, though I often alter their sense and definitions; according to the moderate and approved course of innovation in civil matters, by which, when the state of things is changed, yet the

[1] St. John, v. 43.

[2] Cf. Lucan, x. 21.: — Great thief of nations, to the world sent forth
A dangerous precedent.

Great thief of learning, &c.

forms of words are kept; as Tacitus remarks, "The names of the magistrates are the same."[1]

To return therefore to the use and acceptation of the term *metaphysic*, as I understand the word. It appears by that which has been already said, that I intend Primitive or Summary Philosophy and Metaphysic, which heretofore have been confounded as one, to be two distinct things. For the one I have made a parent or common ancestor to all knowledge; the other, a branch or portion of Natural Philosophy. Now I have assigned to Primitive Philosophy the common principles and axioms which are promiscuous and indifferent to several sciences. I have assigned to it likewise the question of the Relative and Adventitious Conditions of Essences (which I have termed Transcendentals); as Much, Little; Like, Unlike; Possible, Impossible, and the rest; with this provision alone, that they be handled as they have efficacy in nature, and not logically. But the inquiry concerning God, Unity, the nature of Good, Angels and Spirits, I have referred to Natural Theology. It may fairly therefore now be asked, what is left remaining for Metaphysic? Certainly nothing beyond nature; but of nature itself much the most excellent part. And herein without prejudice to truth I may preserve thus much of the conceit of antiquity, that Physic handles that which is most inherent in matter and therefore transitory, and Metaphysic that which is more abstracted and fixed. And again, that Physic supposes in nature only a being and moving and natural necessity; whereas Metaphysic supposes also a mind and idea. For that which I shall say comes perhaps to this. But avoiding all height of

[1] Tac. Ann. i. 3.

language, I will state the matter perspicuously and familiarly. I divided Natural Philosophy into the Inquiry of Causes and the Production of Effects. The Inquiry of Causes I referred to the Theoretical part of Philosophy. This I subdivide into Physic and Metaphysic. It follows that the true difference between them must be drawn from the nature of the causes that they inquire into. And therefore to speak plain and go no further about, Physic inquires and handles the Material and Efficient Causes, Metaphysic the Formal and Final.

Physic then comprehends causes vague, variable, and respective; but does not aspire to the constant.

> Limus ut hic durescit, et hæc ut cera liquescit,
> Uno eodemque igne.[1]

Fire is the cause of induration, but respective to clay; fire is the cause of colliquation, but respective to wax. Now I will divide Physic into three doctrines. For nature is either united and collected, or diffused and distributed. Nature is collected into one, either by reason of the community of the principles of all things, or by reason of the unity of the integral body of the universe. And thus this union of nature has begot two departments of Physic; the one concerning the first principles of things, the other concerning the structure of the universe, or the world; which parts I have likewise usually termed the doctrines concerning the Sums of Things. The third doctrine (which handles nature diffused or distributed) exhibits all the varieties and lesser sums of things. Hence it appears that there are three physical doctrines in all: concerning the prin-

[1] Virg. Ecl. viii. 80.: — As the same fire which makes the soft clay hard,
Makes hard wax soft.

ciples of things; concerning the world or structure of the universe; and concerning nature manifold or diffused. Which last, as I have said, includes all variety of things, and is but as a gloss or paraphrase attending upon the text of natural history. Of these three I cannot report any as totally deficient; but in what truth or perfection they are handled, I make not here any judgment.

But Physic diffused, which touches on the variety and particularity of things, I will again divide into two parts: Physic concerning things Concrete, and Physic concerning things Abstract; or Physic concerning Creatures, and Physic concerning Natures. The one (to make use of logical terms) inquires concerning substances, with every variety of their accidents; and the other, concerning accidents, through every variety of substances. For example, if the inquiry be about a lion, or an oak, these support many different accidents; if contrariwise, it be about heat or gravity, these are found in many different substances. But as all Physic lies in a middle term between Natural History and Metaphysic, the former part (if you observe rightly) comes nearer to Natural History, the latter to Metaphysic. Concrete Physic is subject to the same division as Natural History; being conversant either with the heavens or meteors, or the globe of earth and sea, or the greater colleges, which they call the elements, or the lesser colleges or species, as also with pretergenerations and mechanics. For in all these Natural History investigates and relates the fact, whereas Physic likewise examines the causes; I mean the variable causes, that is, the Material and Efficient. Among these parts of Physic that which inquires concerning the heavenly bodies, is altogether imperfect and de-

fective, though by reason of the dignity of the subject it deserves special consideration. Astronomy has indeed a good foundation in phenomena, yet it is weak, and by no means sound; but astrology is in most parts without foundation even. Certainly astronomy offers to the human intellect a victim like that which Prometheus offered in deceit to Jupiter. Prometheus, in the place of a real ox, brought to the altar the hide of an ox of great size and beauty, stuffed with straw and leaves and twigs. In like manner astronomy presents only the exterior of the heavenly bodies (I mean the number of the stars, their positions, motions, and periods), as it were the hide of the heavens; beautiful indeed and skilfully arranged into systems; but the interior (namely the physical reasons) is wanting, out of which (with the help of astronomical hypotheses) a theory might be devised which would not merely satisfy the phenomena (of which kind many might with a little ingenuity be contrived), but which would set forth the substance, motion, and influence of the heavenly bodies as they really are. For long ago have those doctrines beeen exploded of the Force of the First Mover and the Solidity of the Heaven, — the stars being supposed to be fixed in their orbs like nails in a roof. And with no better reason is it affirmed, that there are different poles of the zodiac and of the world; that there is a Second Mover of counteraction to the force of the first; that all the heavenly bodies move in perfect circles; that there are eccentrics and epicycles whereby the constancy of motions in perfect circles is preserved; that the moon works no change or violence in the regions above it: and the like. And it is the absurdity of these opinions that has driven men to the

diurnal motion of the earth; which I am convinced is most false. But there is scarce any one who has made inquiries into the physical causes, as well of the substance of the heavens both stellar and interstellar, as of the relative velocity and slowness of the heavenly bodies; of the different velocity of motion in the same planet; of the course of motions from east to west, and contrary; of their progressions, stationary positions, and retrogressions; of the elevation and fall of motions in apogee and perigee; of the obliquity of motions, either by spirals winding and unwinding towards the Tropics, or by those curves which they call *Dragons;* of the poles of rotation, why they are fixed in such part of the heaven rather than in any other; and of some planets being fixed at a certain distance from the sun: — such an inquiry as this (I say) has hardly been attempted; but all the labour is spent in mathematical observations and demonstrations. Such demonstrations however only show how all these things may be ingeniously made out and disentangled, not how they may truly subsist in nature; and indicate the apparent motions only, and a system of machinery arbitrarily devised and arranged to produce them, — not the very causes and truth of things. Wherefore astronomy, as it now is, is fairly enough ranked among the mathematical arts, not without disparagement to its dignity; seeing that, if it chose to maintain its proper office, it ought rather to be accounted as the noblest part of Physics. For whoever shall set aside the imaginary divorce between superlunary and sublunary things, and shall well observe the most universal appetites and passions of matter (which are powerful in both globes and make themselves felt through the universal frame of

things), will obtain clear information of heavenly things from those which are seen amongst us; and on the other hand, from that which passes in the heavens he will gain no slight knowledge of some motions of the lower world as yet undiscovered; not only in as far as the latter are influenced by the former, but in as far as they have common passions. Wherefore this, the physical part of astronomy, I pronounce deficient; giving it the name of *Living Astronomy*, in distinction from that stuffed ox of Prometheus, which was an ox in figure only.

As for Astrology, it is so full of superstition, that scarce anything sound can be discovered in it. Notwithstanding, I would rather have it purified than altogether rejected. If however anyone maintains that this science is not based on reason or physical speculations, but on blind experience and the observations of many ages, and on that ground refuses the test of physical reasons (as the Chaldeans professed to do); he may on the same grounds bring back auguries, and believe in divination, entrails, and all kinds of fables; for all these are set forth as the dictates of long experience and traditions passed from hand to hand. But for my part I admit astrology as a part of Physic, and yet attribute to it nothing more than is allowed by reason and the evidence of things, all fictions and superstitions being set aside. To consider the matter however a little more attentively. In the first place what an idle invention is that, that each of the planets reigns in turn for an hour, so that in the space of twenty-four hours each has three reigns, leaving three hours over! And yet this conceit was the origin of our division of the week (a thing so ancient and generally received); as

is very evident from the alternation of days; for the ruling planet at the beginning of the succeeding day is always the fourth in order from the planet of the previous one, by reason of the three supernumerary hours of which I have spoken. Secondly, I do not hesitate to reject as an idle superstition the doctrine of horoscopes and the distribution of houses; which is the very delight of astrology, and has held a sort of Bacchanalian revelry in the heavenly regions. Nor can I sufficiently wonder how illustrious men and eminent in astrology have rested them on such slight foundations; for they say that as experience proves that the solstices, equinoxes, new moons, full moons, and the greater revolutions of the stars, exercise a great and manifest influence over natural bodies, it follows that the more exact and subtle positions of the stars must produce effects likewise more exquisite and secret. But they ought first to have excepted the operations of the sun by manifest heat, and likewise the magnetic influence of the moon on the half-monthly tides (for the daily ebb and flow of the sea is another thing), and then they will find the powers of the rest of the planets over natural things (as far as they are approved by experience) very weak and slight, and almost invisible, even in the greater revolutions. And therefore they should argue in a manner directly contrary; that as those greater revolutions have so little influence, these nice and minute differences of positions have no power at all. Thirdly, those fatalities, that the hour of nativity or conception influences the fortune of the birth, the hour of commencement the fortune of the enterprise, the hour of inquiry the fortune of the thing inquired into, and in short, the doctrines

of *nativities*, *elections*, *inquiries*, and the like frivolities, have in my judgment for the most part nothing sure or solid, and are plainly refuted and convicted by physical reasons. It remains therefore to declare what I retain or approve of in astrology, and what is deficient in that which I approve. For this last it is (the pointing out of deficiencies) which is the object of this discourse; for otherwise (as I have often said) I cannot stay to censure. Among the received doctrines, then, I think that concerning *revolutions* has more soundness than the rest. But it will perhaps be better to lay down certain rules, as a standard by which we may weigh and examine astrological matters, so as to retain what is useful and to reject what is frivolous. First then, as I have before advised, let the greater revolutions be retained, but the smaller revolutions of horoscopes and houses be dismissed. The former are like great guns, and can strike from afar; the latter are like little bows, and cannot transmit their force over much space. Secondly; the operation of the heavenly bodies does not affect all kinds of bodies, but only the more tender; such as humours, air and spirit; here however the operations of the heat of the sun and heavenly bodies must be excepted; which doubtless penetrates both to metals and to a great number of subterraneous bodies. Thirdly; every operation of heavenly bodies extends rather to masses than to individuals; though it affects indirectly some individuals also; such, namely, as are more susceptible, and of softer wax as it were, than the rest of their species; as when a pestilent condition of air seizes on the less resisting bodies and passes by those which have more power of resistance. The fourth rule is not unlike the preceding; every operation of the

heavenly bodies sheds its influence and power, not on small periods of time or within narrow limits, but upon the larger spaces. And therefore predictions of the temperature of the year may possibly be true; but those of particular days are rightly held of no account. The last rule (which has always been held by the wiser astrologers) is that there is no fatal necessity in the stars; but that they rather incline than compel. I will add one thing besides (wherein I shall certainly seem to take part with astrology, if it were reformed); which is, that I hold it for certain that the celestial bodies have in them certain other influences besides heat and light; which very influences however act by those rules laid down above, and not otherwise. But these lie concealed in the depths of Physic, and require a longer dissertation. I have thought fit therefore (on due consideration of what has been said) to set down as a desideratum an astrology framed in conformity with these principles; and as I have termed Astronomy based on Physical Reasons *Living Astronomy*, so Astrology similarly grounded I call *Sane Astrology*. And though what I have already said will in no slight degree contribute to the rectification and completion of this art, yet according to my custom I will add a few remarks which will clearly explain out of what materials it should be composed, and to what end it should be applied. In the first place, let there be received into Sane Astrology the doctrine concerning the commixture of rays; that is the conjunctions, oppositions, and other combinations or aspects of planets with regard to one another. And to this same part also I refer the passage of the planets through the signs of the zodiac, and their position under the same signs;

for the position of a planet under a sign is a kind of conjunction of it with the stars of that sign. And in like manner also ought the oppositions and other combinations of the planets with regard to the stars of the signs to be observed; which has not hitherto been fully done. But these commixtures of the rays of fixed stars with one another, though useful in contemplating the structure of the universe and the nature of the regions lying below them, are of no avail for predictions, because they are always alike. Secondly, let there be received the approaches of each individual planet to the perpendicular, and its regressions from it, according to the climates of countries. For every planet, no less than the sun, has its summer and winter, in which as its rays fall more or less perpendicular, their force is stronger or weaker. For I have no doubt but that the moon in Leo has more power over natural bodies in our planet than when in Pisces; not because when in Leo the moon affects the heart, and when in Pisces the feet, as they talk; but by reason of her elevation towards the perpendicular and approximation to the larger stars, in the same manner as the sun. Thirdly, let there be received the apogees and perigees of the planets, with a sufficient distinction as to what is due to the inherent vigour of the planet, and what to its proximity to us. For a planet is more active in its apogee or elevation, but more communicative in its perigee or descent. Fourthly, let there be received (to speak summarily) all the remaining accidents of the motions of planets; what are the accelerations and retardations of each in its course; what their progressions, actions, and regressions; what their distances from the sun, combustions, increases and diminutions of light, eclipses and

the like; for all these things help to make the rays of the planets act more forcibly or more feebly, and in different modes and with different virtues. These four remarks relate to the radiations of the stars. Fifthly, let everything be received which may in any way disclose and explain the natures of the stars, whether erratic or fixed, in their proper essence and activity; as their size, their colour and aspect, their twinkling and vibration of light, their situation with reference to the poles or the equinox, their asterisms; which of them are more mingled with other stars and which more solitary; which are higher, and which lower; which of the fixed stars are within the path of the sun and planets (that is within the zodiac), and which without; which of the planets is swifter, which slower; which of them move in the ecliptic, and which deviate to right or left of it; which of them may be retrograde, and which cannot; which of them may be at any distance from the sun, and which of them are confined to a certain limit; which of them move swifter in perigee, which in apogee; finally the anomalies of Mars, the wandering of Venus, the labours and wonderful passions which have been detected more than once both in the Sun and Venus; and any other things of the like nature. Lastly let there be received also the particular natures and inclinations of the planets, and likewise of the fixed stars, as handed down by tradition; which as they are transmitted with very general consent, ought not (except when they are plainly at variance with physical reasons) to be lightly rejected. From such observations is Sane Astrology constructed, and by them alone should schemes of the heavens be formed and interpreted.

Sane Astrology is applied more confidently to *predictions*, but more cautiously to *elections;* in both cases however within due limits. *Predictions* may be made of comets to come, which (I am inclined to think) may be foretold; of all kinds of meteors, of floods, droughts, heats, frosts, earthquakes, irruptions of water, eruptions of fire, great winds and rains, the various seasons of the year, plagues, epidemic diseases, plenty and dearth of grain, wars, seditions, schisms, transmigrations of peoples, and in short of all commotions or greater revolutions of things, natural as well as civil. But these predictions may also be made (though not so certainly) with reference to events more special and perhaps singular, if after the general inclinations of such times and seasons have been ascertained, they be applied with a clear judgment, either physical or political, to those species or individuals which are most liable to accidents of this nature; as for instance, if any one from a foreknowledge of the seasons of the year shall pronounce them more favourable or injurious to olives than to vines, to pulmonary than to liver complaints, to the inhabitants of hills than to those of valleys, to monks than to courtiers (by reason of their different manner of living); or if any one from knowledge of the influence which celestial bodies have upon human minds should discover it to be more favourable or more adverse to peoples than to kings, to learned and inquisitive men than to bold and warlike, to men of pleasure than to men of business or politicians. There are innumerable things of this kind; but they require (as I said before) not only that general knowledge derived from the stars (which are actives), but also a particular knowledge of the subjects (which are

passives). Nor are *elections* to be altogether rejected; but less confidence is to be placed in them than in predictions. For we see that in planting and sowing and grafting, observation of the age of the moon is a thing not altogether frivolous. And there are many instances of the kind. But these elections also, even more than predictions, must be guided by our rules. And it must always be observed, that elections hold good in those cases only where both the virtue of the heavenly bodies is such as does not quickly pass, and the action of the inferior bodies is such as is not suddenly accomplished; which is the case in those examples cited above; for neither the changes of the moon nor the growth of plants are effected in an instant. As for those which depend upon exactness to a moment, they are to be rejected altogether. But many such cases are to be found likewise (though a man would not think it) in elections concerning civil matters. And if any one complains that while I have given some indication of the materials from which this improved astrology may be extracted, and likewise of the purposes for which it may be advantageously used, I have said nothing about the manner of extracting it, he does not deal fairly with me; for he requires of me the art itself, for which I am not accountable. Upon the question which he asks however I will say thus much. There are four ways only by which this science can be approached. First by future experiments; secondly by past experiments; thirdly by traditions; and lastly by physical reasons. With regard to future experiments, what need is there of saying anything? seeing it requires many ages to collect a sufficient number of them; so that it is useless to speculate about

them. For past experiments, they are no doubt within man's reach; though to collect them is a work of great labour, and one requiring much leisure. For astrologers (if they would do themselves justice) may faithfully extract from history all the greater disasters (as inundations, plagues, battles, seditions, deaths of kings, and the like), and may examine (not according to the subtleties of horoscopes, but by those rules of revolutions which I have shadowed out) what the position of the heavenly bodies was at the times; so that where there is found a manifest agreement and coincidence of events, there a probable rule of prediction may be established. As to traditions, they must be carefully sifted, that what is plainly repugnant to physical reasons may be rejected, and what is in conformity with them may stand upon its own authority. Lastly of physical reasons, those are most adapted to this investigation which make inquiry into the universal appetites and passions of matter, and the simple and genuine motions of bodies. For upon these wings we ascend most safely to these celestial material substances. And so much for Sane Astrology.

Of astrological insanity (besides those fictions which I remarked above) there is another portion, which must not be omitted; though it ought properly to be excluded from astrology, and removed to what is called celestial magic. It rests upon a wonderful figment of the human mind,—namely, that any favourable position of the stars may be received on seals or signets (say of some metal or gem qualified for the purpose), by which the felicity of the hour, which would otherwise pass, may be arrested and as it were fixed as it

flies. So the poet complains heavily that so noble an ancient art should have been lost.

> Annulus infuso non vivit mirus Olympo,
> Non magis ingentes humili sub lumine Phœbos
> Fert gemma, aut celso divulsas cardine Lunas.[1]

It is true that the relics of saints and their virtues have been allowed by the Church of Rome (for in divine and immateriate things lapse of time does not matter); but to treasure up the relics of heaven, whereby the hour which is already past and as it were dead should revive and be continued, is mere superstition. Let these fancies then be dismissed, if the Muses be not turned to old women.

Abstract Physics may most rightly be divided into two parts — the doctrine concerning the Configurations of Matter, and the doctrine concerning Appetites and Motions. Both of these I will cursorily enumerate, and thence may be derived some shadow of the true Physic of Abstracts. The *Configurations of Matter* are, Dense, Rare; Heavy, Light; Hot, Cold; Tangible, Pneumatic; Volatile, Fixed; Determinate, Fluid; Moist, Dry; Fat, Crude; Hard, Soft; Fragile, Tensile; Porous, Close; Spirituous, Jejune; Simple, Compound; Absolute, Imperfectly Mixed; Fibrous and Venous, Simple of Structure, or Equal; Similar, Dissimilar; Specific, Non-Specific; Organic, Inorganic; Animate, Inanimate. Further I do not go. For Sensible and Insensible, Rational and Irrational, I refer to the doctrine concerning Man. Of *Appetites* and *Motions* there are two kinds. There are simple motions,

[1] Not now the ring can in its circlet store
Heaven's living influence: the gem no more
Beneath its modest lustre bears the might
Of the great orbs that govern day and night.

in which lies the root of all natural actions, subject to the conditions of the configurations of matter. And there are Compound or Produced Motions; with which last the received philosophy (which takes but slight hold of the body of nature) commences. But compound motions of this kind (such as Generation, Corruption, and the rest) ought to be accounted as the sums or products of simple motions, rather than as primitive motions. The simple motions are, motion of *Resistance* — commonly called motion to prevent penetration of dimensions; motion of *Connexion* — which they call motion of abhorrence of a vacuum; motion of *Liberty*, to prevent preternatural compression or extension; motion into a *New Sphere*, or for the purpose of rarefaction or condensation; motion of the *Second Connexion*, or to prevent solution of continuity; motion of the *Greater Congregation*, or towards masses of connatural bodies, commonly called natural motion; motion of *Lesser Congregation*, commonly called motion of sympathy and antipathy; motion of *Disposition*, or for the ordering of the parts with reference to the whole; motion of *Assimilation*, or multiplication of its own nature upon another body; motion of *Excitation*, where the nobler agent excites a motion dormant and latent in another; motion of *Signature* or *Impression;* that is, operation without communication of substance; motion of *Royalty*, or restraint of other motions by the motion predominant; motion *without limit*, or spontaneous rotation; motion of *Trepidation*, or Systole and Diastole, in bodies (that is) placed between things attractive and repugnant; lastly, motion of *Repose*, or *abhorence of motion*, which is also causative of very many things. Such are Simple Motions; which truly

proceed from the inward recesses of nature, and which by complication, continuation, alternation, restraint, repetition, and various modes of combination, form those compound motions or sums of motions which are generally received, or others like them. The sums of motion are those motions so much talked of, — generation, corruption; augmentation, diminution; alteration, and local motion; likewise mixture, separation; conversion. There remain as Appendices of Physic, the *measurements of motions;* namely, what is the effect of the *how much* or *dose* in nature; what of distance, which is not unfitly called the orb of virtue or activity; what of rapidity or slowness; what of short or long delay; what of the force or dulness of the thing; what of the stimulus of surrounding things. And these are genuine parts of the true Physic of Abstracts; for in the configurations of matter, in simple motions, in the sums or aggregates of motions, and in the measures of motions, the Physic of Abstracts is perfected. For voluntary motion in animals; the motion which takes place in the actions of the senses; motion of imagination, appetite, and will; motion of the mind, determination, and intellectual faculties; these I refer to their own proper doctrines. I repeat however that all these above mentioned are to be no further handled in Physic than the inquiry of their Material and Efficient causes; for as to their Formal and Final causes they are rehandled in Metaphysic.

I will subjoin two notable appendices of Physic, which regard not so much the matter as the manner of inquiry; namely *Problems of Nature* and *Dogmas of Ancient Philosophers.* The first is an appendix to nature manifold or scattered; the other, to nature united

or summary. Both relate to the skilful proposing of *Doubts;* which is no despicable part of science. Problems deal with particular doubts; Dogmas with general ones, concerning first principles and the fabric of the universe. Of Problems there is a noble example in the books of Aristotle; a kind of work which certainly deserved not only to be honoured with the praises of posterity but to be continued by their labours; seeing that new doubts are daily arising. In this however there is a caution to be applied, which is of great importance. The registering and proposing of doubts has a double use: first it guards philosophy against errors, when upon a point not clearly proved no decision or assertion is made (for so error might beget error), but judgment is suspended and not made positive; secondly, doubts once registered are so many suckers or sponges which continually draw and attract increase of knowledge; whence it comes that things which, if doubts had not preceded, would have been passed by lightly without observation, are through the suggestion of doubts attentively and carefully observed. But these two advantages are scarcely sufficient to countervail one inconvenience which will intrude itself, if it be not carefully debarred; which is that a doubt if once allowed as just, and authorised as it were, immediately raises up champions on either side, by whom this same liberty of doubting is transmitted to posterity; so that men bend their wits rather to keep the doubt up than to determine and solve it. Of this examples everywhere occur both in lawyers and scholars, who when a doubt has been once admitted will have it remain for ever a doubt, and hold to authority in doubting as much as in asserting; whereas the legitimate use of

reason is to make doubtful things certain and not certain things doubtful. Wherefore I say that a *calendar of doubts* or *problems in nature* is wanting, and I would wish it to be taken in hand; if only care be taken that as knowledge daily increases (which it certainly will, if men listen to me) those doubts which are clearly sifted and settled be blotted out from the list. And to this calendar I would annex another of no less utility; for seeing that in every inquiry there are found things plainly true, things doubtful, and things plainly false, it would be most advantageous to add to the calendar of doubts a calendar of *falsehoods and popular errors* prevalent either in natural history or the dogmas of philosophers; that the sciences may be no longer troubled with them.

With regard to the dogmas of the ancient philosophers, as those of Pythagoras, Philolaus, Xenophanes, Anaxagoras, Parmenides, Leucippus, Democritus, and the rest, (which men usually pass over with disdain), it will not be amiss to look upon them somewhat more modestly. For though Aristotle, after the Ottoman fashion, thought that he could not reign with safety unless he put all his brethren to death, yet for those who aim not at dominion or authority but at the inquiry and illustration of truth, it cannot but seem a useful thing to behold at one view the several opinions of different men touching the nature of things. Not however that there is any hope of gaining any truth of the purer kind from these or the like theories. For as the same phenomena, the same calculations, are compatible with the astronomical principles both of Ptolemy and Copernicus; so this common experience of which we are now in possession, and the ordinary face

of things, may adapt itself to many different theories; whereas to find the real truth requires another manner of severity and attention. For as Aristotle says elegantly, "that children when they begin to lisp call every woman mother, but afterwards come to distinguish their own," so certainly experience when in childhood will call every philosophy mother, but when it comes to ripeness it will discern the true mother. In the meantime it will be good to peruse the several differing systems of philosophy, like different glosses upon nature; whereof it may be that one is better in one place and another in another. Therefore I wish a work to be compiled with diligence and judgment out of the lives of the ancient philosophers, the collection of *placita* made by Plutarch, the citations of Plato, the confutations of Aristotle, and the scattered notices which we have in other books, both ecclesiastical and heathen (Lactantius, Philo, Philostratus, and the rest), concerning the *ancient philosophies*. For I do not find any such work extant. But here I must give warning that it be done distinctly, so that the several philosophies may be set forth each throughout by itself, and not by titles packed and faggoted up together, as has been done by Plutarch. For when a philosophy is entire, it supports itself, and its doctrines give light and strength the one to the other; whereas if it be broken, it will seem more strange and dissonant. Certainly when I read in Tacitus of the actions of Nero or Claudius, invested with all the circumstances of times, persons, and occasions, I see nothing in them very improbable; but when I read the same in Suetonius Tranquillus, gathered into titles and common places, and not presented in order of time, they seem something prodigious and

quite incredible. And the case is the same in philosophy, when propounded entire and when dissected and dismembered. Neither do I exclude from this calendar of the dogmas of the old philosophers modern theories and doctrines; such as that of Theophrastus Paracelsus, eloquently reduced into a body and harmony by Severinus the Dane; or that of Telesius of Consentium, who revived the philosophy of Parmenides, and so turned the weapons of the Peripatetics against themselves; or of Patricius the Venetian, who sublimated the fumes of the Platonists; or of our countryman Gilbert, who revived the doctrines of Philolaus; or of any other worthy to be admitted. Of these however (since their entire works are extant) I would only have summaries made therefrom and added to the rest. And so much for Physic and its Appendices.

For Metaphysic, I have already assigned to it the inquiry of Formal and Final Causes; which assignation, as far as it relates to Forms, may seem nugatory; because of a received and inveterate opinion that the Essential Forms or true differences of things cannot by any human diligence be found out; an opinion which in the meantime implies and admits that the invention of Forms is of all parts of knowledge the worthiest to be sought, if it be possible to be found. And as for the possibility of finding it, they are ill discoverers who think there is no land where they can see nothing but sea. But it is manifest that Plato, a man of sublime wit (and one that surveyed all things as from a lofty cliff), did in his doctrine concerning Ideas descry that Forms were the true object of knowledge; howsoever he lost the fruit of this most true opinion by considering and trying to apprehend Forms as absolutely ab-

stracted from matter; whence it came that he turned aside to theological speculations, wherewith all his natural philosophy is infected and polluted. But if we fix our eyes diligently seriously and sincerely upon action and use, it will not be difficult to discern and understand what those Forms are the knowledge whereof may wonderfully enrich and benefit the condition of men. For as to the Forms of Substances (Man only excepted, of whom the Scripture saith, "That He made man of the dust of the earth and breathed into his nostrils the breath of life," [1] and not as of all other creatures, "Let the earth or the waters bring forth," [2]) — the Forms of Substances I say (as they are now by compounding and transplanting multiplied) are so perplexed and complicated, that it is either vain to inquire into them at all, or such inquiry as is possible should be put off for a time, and not entered upon until forms of a more simple nature have been rightly investigated and discovered. For as it would be neither easy nor of any use to inquire the form of the sound which makes any word, since words, by composition and transposition of letters, are infinite; whereas to inquire the form of the sound which makes any simple letter (that is, by what collision or application of the instruments of voice it is produced) is comprehensible, nay easy; and yet these forms of letters once known will lead us directly to the forms of words; so in like manner to inquire the form of a lion, of an oak, of gold, nay even of water or air, is a vain pursuit; but to inquire the form of dense, rare, hot, cold, heavy, light, tangible, pneumatic, volatile, fixed, and the like, as well configurations as motions, which in treating of Physic I have in great

[1] Gen. ii. 7. [2] Gen. i. 20. 24.

part enumerated (I call them *Forms of the First Class*), and which (like the letters of the alphabet) are not many and yet make up and sustain the essences and forms of all substances; — this, I say, it is which I am attempting, and which constitutes and defines that part of Metaphysic of which we are now inquiring. Not but that Physic takes consideration of the same natures likewise (as has been said); but that is only as to their variable causes. For example; if the cause of whiteness in snow or froth be inquired, it is well rendered, that it is the subtle intermixture of air and water. But nevertheless this is far from being the form of whiteness, seeing that air intermixed with powdered glass or crystal, would create a similar whiteness, no less than when mixed with water; it is only the efficient cause, which is nothing else than the vehicle of the form. But if the inquiry be made in Metaphysic you will find something of this sort; that two transparent bodies intermixed, with their optical portions arranged in a simple and regular order, constitute whiteness. This part of Metaphysic I find deficient; whereat I marvel not, because I hold it not possible that the Forms of things can be invented by that course of invention hitherto used; the root of the evil, as of all others, being this; that men have used to sever and withdraw their thoughts too soon and too far from experience and particulars, and have given themselves wholly up to their own meditations and arguments.

But the use of this part of Metaphysic, which I reckon amongst the deficient, is of the rest the most excellent in two respects; the one, because it is the duty and virtue of all knowledge to abridge the circuits and long ways of experience (as much as truth

will permit), and to remedy the ancient complaint that "life is short and art is long."[1] And this is best performed by collecting and uniting the axioms of sciences into more general ones, and such as may comprehend all individual cases. For knowledges are as pyramids, whereof history and experience are the basis. And so of Natural Philosophy the basis is Natural History; the stage next the basis is Physic; the stage next the vertical point is Metaphysic. As for the cone and vertical point ("the work which God worketh from the beginning to the end,"[2] namely, the summary law of nature) it may fairly be doubted whether man's inquiry can attain to it. But these three are the true stages of knowledge; which to those that are puffed up with their own knowledge, and rebellious against God, are indeed no better than the giants' three hills;

> Ter sunt conati imponere Pelio Ossam,
> Scilicet atque Ossæ frondosum involvere Olympum:[3]

but to those who abasing themselves refer all things to the glory of God, they are as the three acclamations: Holy, Holy, Holy. For God is holy in the multitude of his works, holy in the order or connexion of them, and holy in the union of them. And therefore the speculation was excellent in Parmenides and Plato (although in them it was but a bare speculation), "that all things by a certain scale ascend to unity." So then always that knowledge is worthiest which least burdens the intellect with multiplicity; and this appears to be Metaphysic, as that which considers chiefly the simple forms of things (which I have above

[1] Hippocrates, Aph. i. 1.
[2] Eccles. iii. 11.
[3] Virg. Georg. i. 281.: —

> Mountain on mountain thrice they strove to heap,
> Olympus, Ossa, piled on Pelion's steep.

termed *forms of the first class*); since although few in number, yet in their commensurations and co-ordinations they make all this variety. The second respect which ennobles this part of Metaphysic, is that it enfranchises the power of men to the greatest liberty, and leads it to the widest and most extensive field of operation. For Physic carries men in narrow and restrained ways, imitating the ordinary flexuous courses of Nature; but the ways of the wise are everywhere broad; to wisdom (which was anciently defined to be the knowledge of things divine and human) there is ever abundance and variety of means. For physical causes give light and direction to new inventions in similar matter. But whosoever knows any Form, knows also the utmost possibility of superinducing that nature upon every variety of matter, and so is less restrained and tied in operation, either to the basis of the matter or to the condition of the efficient; which kind of knowledge Solomon likewise, though in a more divine sense, elegantly describes, "Thy steps shall not be straitened, and when thou runnest thou shalt not stumble;"[1] meaning thereby that the ways of wisdom are not much liable either to straitness or obstructions.

The second part of Metaphysic is the inquiry of Final Causes, which I report not as omitted, but as misplaced. For they are generally sought for in Physic, and not in Metaphysic. And yet if it were but a fault in order I should not think so much of it; for order is matter of illustration, but pertains not to the substance of sciences. But this misplacing has caused a notable deficience, and been a great misfortune to philosophy. For the handling of final causes in physics has driven

[1] Prov. iv. 12.

away and overthrown the diligent inquiry of physical causes, and made men to stay upon these specious and shadowy causes, without actively pressing the inquiry of those which are really and truly physical; to the great arrest and prejudice of science. For this I find done, not only by Plato, who ever anchors upon that shore, but also by Aristotle, Galen, and others, who also very frequently strike upon these shallows. For to introduce such causes as these, "that the hairs of the eyelids are for a quickset and fence about the sight;" or "that the firmness of the skins and hides of living creatures is to defend them from the extremities of heat and cold;" or "that the bones are for columns or beams, whereupon the frames of the bodies of living creatures are built;" or "that the leaves of trees are for protecting the fruit from the sun and wind;" or "that the clouds are formed above for watering the earth;" or "that the thickness and solidity of the earth is for the station and mansion of living creatures," and the like, is a proper inquiry in Metaphysic, but in Physic it is impertinent.. Nay, as I was going to say, these discoursing causes (like those fishes they call *remoras*, which are said to stick to the sides of ships) have in fact hindered the voyage and progress of the sciences, and prevented them from holding on their course and advancing further; and have brought it to pass that the inquiry of physical causes has been long neglected and passed in silence. And therefore the natural philosophy of Democritus and others, who removed God and Mind from the structure of things, and attributed the form thereof to infinite essays and proofs of nature (which they termed by one name, Fate or Fortune), and assigned the causes of particular

things to the necessity of matter, without any intermixture of final causes, seems to me (so far as I can judge from the fragments and relics of their philosophy) to have been, as regards physical causes, much more solid and to have penetrated further into nature than that of Aristotle and Plato; for this single reason, that the former never wasted time on final causes, while the latter were ever inculcating them. And in this Aristotle is more to be blamed than Plato, seeing that he left out the fountain of final causes, namely God, and substituted Nature for God; and took in final causes themselves rather as the lover of logic than of theology. And I say this, not because those final causes are not true and worthy to be inquired in metaphysical speculations; but because their excursions and irruptions into the limits of physical causes has bred a waste and solitude in that track. For otherwise, if they be but kept within their proper bounds, men are extremely deceived if they think there is any enmity or repugnancy at all between the two. For the cause rendered, "that the hairs about the eyelids are for the safeguard of the sight," does not impugn the cause rendered, "that pilosity is incident to orifices of moisture;"

Muscosi fontes, &c.[1]

Nor the cause rendered, "that the firmness of hides in animals is for the armour of the body against extremities of heat or cold," does not impugn the cause rendered, "that this firmness is caused from the contraction of the pores in the outward parts by cold and depredation of the air;" and so of the rest; both causes being perfectly compatible, except that one declares an intention, the other a consequence only. Neither does this

[1] Virg. Eclog. vii. 45.: — The mossy springs.

call in question or derogate from divine providence, but rather highly confirms and exalts it. For as in civil actions he is far the greater and deeper politician that can make other men the instruments of his ends and desires and yet never acquaint them with his purpose (so as they shall do what he wills and yet not know that they are doing it), than he that imparts his meaning to those he employs; so does the wisdom of God shine forth more admirably when nature intends one thing and Providence draws forth another, than if he had communicated to all natural figures and motions the characters and impressions of his providence. For instance, Aristotle, when he had made nature pregnant with final causes, laying it down that "Nature does nothing in vain,[1] and always effects her will when free from impediments," and many other things of the same kind, had no further need of a God. But Democritus and Epicurus, when they proclaimed their doctrine of atoms, were tolerated so far by some of the more subtle wits; but when they proceeded to assert that the fabric of the universe itself had come together through the fortuitous concourse of the atoms, without a mind, they were met with universal ridicule. Thus so far are physical causes from withdrawing men from God and Providence, that contrariwise, those philosophers who have been occupied in searching them out can find no issue but by resorting to God and Providence at the last. And so much for Metaphysic; the latter part whereof, concerning Final Causes, I allow to be extant in books both physical and metaphysical; in the latter rightly, in the former wrongly, by reason of the inconvenience that ensues thereon.

[1] Arist. Polit. i. 2.

CHAP. V.

Division of the operative doctrine concerning Nature into Mechanic *and* Magic, *which correspond with the divisions of the speculative doctrine;* Mechanic *answering to* Physic, Magic *to* Metaphysic. *Purification of the word Magic. Two appendices of the operative doctrine.* Inventory of the possessions of man, *and* Catalogue of Polychrests, *or things of general use.*

THE operative doctrine concerning nature I will likewise divide into two parts, and that by a kind of necessity, for this division is subject to the former division of the speculative doctrine; and as Physic and the inquisition of Efficient and Material causes produces Mechanic, so Metaphysic and the inquisition of Forms produces Magic. For the inquisition of Final Causes is barren, and like a virgin consecrated to God produces nothing. I know that there is also a kind of Mechanic often merely empirical and operative, which does not depend on Physic; but this I have remitted to Natural History, taking it away from Natural Philosophy. I speak only of that mechanic which is connected with physical causes. Nevertheless between these two kinds of mechanic there is also another which is not altogether operative, yet does not properly reach to philosophy. For all inventions of works which are known to men have either come by chance and so been handed down from one to another, or they have been purposely sought for. But those which have been found by intentional experiment have been either worked out by the light of causes and axioms, or detected by extending or transferring or putting together former inventions; which is a matter of ingenuity and sagacity

rather than philosophy. And this kind, which I noways despise, I will presently touch on by the way, when I come to treat of *learned experience* among the parts of logic. But the mechanic of which I now treat is that which has been handled by Aristotle promiscuously, by Hero in spirituals, by Georgius Agricola, a modern writer, very diligently in minerals, and by many other writers in particular subjects; so that I have no omissions to mark in this part, except that promiscuous mechanics, after the manner of Aristotle, ought to have been more diligently continued by the moderns, especially with selection of those whereof either the causes are more obscure, or the effects more noble. But they who pursue these studies do but creep as it were along the shore,

—— premendo litus iniquum.[1]

For it seems to me there can hardly be discovered any radical or fundamental alterations and innovations of nature, either by accidents or essays of experiments, or from the light and direction of physical causes; but only by the discovery of forms. If then I have set down that part of metaphysic which treats of forms as deficient, it must follow that I do the like of natural magic, which has relation thereunto. But I must here stipulate that magic, which has long been used in a bad sense, be again restored to its ancient and honourable meaning. For among the Persians magic was taken for a sublime wisdom, and the knowledge of the universal consents of things; and so the three kings who came from the east to worship Christ were called by the name of Magi. I however understand it as the science which applies the knowledge of hidden forms

[1] Hor. Od. ii. 10.: —— hugging the coast.

to the production of wonderful operations; and by uniting (as they say) actives with passives, displays the wonderful works of nature. For as for that natural magic which flutters about so many books, embracing certain credulous and superstitious traditions and observations concerning sympathies and antipathies, and hidden and specific properties, with experiments for the most part frivolous, and wonderful rather for the skill with which the thing is concealed and masked than for the thing itself; it will not be wrong to say that it is as far differing in truth of nature from such a knowledge as we require, as the story of King Arthur of Britain, or Hugh of Bordeaux, and such like imaginary heroes, differs from Cæsar's Commentaries in truth of story. For it is manifest that Cæsar did greater things in reality than those imaginary heroes were feigned to do, but he did them not in that fabulous manner. Of this kind of learning the fable of Ixion was a figure; who designing to embrace Juno, the Goddess of Power, had intercourse with a fleeting cloud; out of which he begot Centaurs and Chimæras. So they who are carried away by insane and uncontrollable passion after things which they only fancy they see through the clouds and vapours of imagination, shall in place of works beget nothing else but empty hopes and hideous and monstrous spectres. But this popular and degenerate natural magic has the same kind of effect on men as some soporific drugs, which not only lull to sleep, but also during sleep instil gentle and pleasing dreams. For first it lays the understanding asleep by singing of specific properties and hidden virtues, sent as from heaven and only to be learned from the whispers of tradition; which makes men no longer alive and awake

for the pursuit and inquiry of real causes, but to rest content with these slothful and credulous opinions; and then it insinuates innumerable fictions, pleasant to the mind, and such as one would most desire, — like so many dreams. And it is worth while to note that in these sciences which hold too much of imagination and belief (such as that light Magic of which I now speak, Alchemy, Astrology, and others the like) the means and theory are ever more monstrous than the end and action at which they aim. The conversion of silver, quicksilver, or any other metal into gold, is a thing difficult to believe; yet it is far more probable that a man who knows clearly the natures of weight, of the colour of yellow, of malleability and extension, of volatility and fixedness, and who has also made diligent search into the first seeds and menstruums of minerals, may at last by much and sagacious endeavour produce gold; than that a few grains of an elixir should in a few moments of time be able to turn other metals into gold by the agency of that elixir, as having power to perfect nature and free it from all impediments. So again the retarding of old age or the restoration of some degree of youth, are things hardly credible; yet it is far more probable that a man who knows well the nature of arefaction and the depredations of the spirits upon the solid parts of the body, and clearly understands the nature of assimilation and of alimentation, whether more or less perfect, and has likewise observed the nature of the spirits, and the flame as it were of the body, whose office is sometimes to consume and sometimes to restore, shall by diets, bathings, anointings, proper medicines, suitable exercises, and the like, prolong life, or in some degree renew the vigour of youth; than that it can

be done by a few drops or scruples of a precious liquor or essence. Again, that fates can be drawn from the stars is more than men will at once or lightly admit; but that the hour of nativity (which is very often either delayed or hastened by many natural accidents) should influence the fortune of a whole life; or that the hour of question has a fatal connexion with the subject of inquiry; these you may call mere follies. But such is the immoderation and intemperance of men that they not only promise to themselves things impossible, but expect to obtain the most difficult things without trouble or toil, as in a holiday recreation. And so much for Magic; whereof I have both vindicated the name itself from discredit, and separated the true kind from the false and ignoble.

But to this operative department of natural philosophy there belong two appendices, both of great value. The first is that there be made an Inventory of the Possessions of Man, wherein should be set down and briefly enumerated all the goods and possessions (whether derived from the fruits and proceeds of nature or of art) which men now hold and enjoy; with the addition of things once known but now lost; in order that those who address themselves to the discovery of new inventions may not waste their pains upon things already discovered and extant. Which calendar will be more workmanlike and more serviceable too, if you add to it a list of those things which are in common opinion reputed impossible in every kind, noting, in connexion with each, what thing is extant which comes nearest in degree to that impossibility; that by the one human invention may be stimulated, and by the other it may to a certain extent be directed; and that by these optatives

and potentials active discoveries may the more readily be deduced. The second is, that there be also made a calendar of those experiments which are of most general use, and lead the way to the invention of others. For example, the experiment of the artificial freezing of water by the mixture of ice and bay salt bears on an infinite number of things; for it reveals a secret method of condensation, than which nothing is more serviceable to man. For rarefactions we have fire at hand, but for the means of condensation we are in difficulty. Now it would greatly tend to abridge the work of invention if *Polychrests* of this kind were set down in a proper catalogue.

CHAP. VI.

Of the great Appendix of Natural Philosophy, both Speculative and Operative, namely Mathematic; *and that it ought rather to be placed among Appendices than among Substantive Sciences. Division of Mathematic into* Pure *and* Mixed.

Aristotle has well remarked that Physic and Mathematic produce Practice or Mechanic;[1] wherefore as we have already treated of the speculative and operative part of natural philosophy, it remains to speak of Mathematic, which is a science auxiliary to both. Now this in the common philosophy is annexed as a third part to Physic and Metaphysic; but for my part, being now engaged in reviewing and rehandling these things, if I meant to set it down as a substantive and principal science, I should think it more agreeable both to the

[1] Arist. Præf. ad Quæst. Mechan.

nature of the thing and the clearness of order to place it as a branch of Metaphysic. For Quantity (which is the subject of Mathematic), when applied to matter, is as it were the dose of Nature, and is the cause of a number of effects in things natural; and therefore it must be reckoned as one of the Essential Forms of things. And so highly did the ancients esteem the power of figures and numbers, that Democritus ascribed to the figures of atoms the first principles of the variety of things; and Pythagoras asserted that the nature of things consisted of numbers. In the meantime it is true that of all natural forms (such as I understand them) Quantity is the most abstracted and separable from matter; which has likewise been the cause why it has been more carefully laboured and more acutely inquired into than any of the other forms, which are all more immersed in matter. For it being plainly the nature of the human mind, certainly to the extreme prejudice of knowledge, to delight in the open plains (as it were) of generalities rather than in the woods and inclosures of particulars, the mathematics of all other knowledge were the goodliest fields to satisfy that appetite for expatiation and meditation. But though this be true, regarding as I do not only truth and order but also the advantage and convenience of mankind, I have thought it better to designate Mathematics, seeing that they are of so much importance both in Physics and Metaphysics and Mechanics and Magic, as appendices and auxiliaries to them all. Which indeed I am in a manner compelled to do, by reason of the daintiness and pride of mathematicians, who will needs have this science almost domineer over Physic. For it has come to pass, I know not how, that Mathematic and